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THE 37th CONVENTION

Chapters and clubs are urged to appoint delegates to the 37th Convention of our great Society, which is scheduled for Atlantic City, Tuesday, December 29, 1936, at 4 p.m. Among important items of business to be presented by the Executive Committees are:

1. Petitions for charters for chapters from:

a. George Washington University.

b. Carnegie Institute of Technology.

c. The University of Utah.

d. The State College of Oregon.

The printed petitions from these institutions were sent to chapter secretaries early in November.

2. Proposed amendments to the National Constitution:

These appeared in full in the September issue of the Quarterly.

3. The convention will be called upon to elect a member of the Executive Committee to succeed Dr. Henry V. Wilson whose term expires this year; and also a member of the Alumni Com-

mittee to succeed Dr. Henry G. Knight, whose term of office expires this year. Nominations for these two offices are in order at any time and may be sent to the National Secretary who will hand them to the Nominating Committee, or to the Nominating Committee, which is as follows: Prof. B. F. Kingsbury, Cornell; Prof. Walter L. Upson, Washington University; Prof. Ralph W. Chaney, University of California.

4. The national officers hope that every chapter and every club will be represented at the convention, and that delegates will make proposals regarding the policies of our rapidly expanding society for the consideration of the officers at their annual Spring meeting.

BENEFACTIONS OF SURGERY TO MAN*

OWEN H. WANGENSTEEN, M.D.

The healing art of medicine, it has been said, is the oldest of all the arts. Hippocrates, the Father of Medicine, referred to it as "the art." In sponsoring this discussion relating to Medical Science and Human Welfare, Sigma Xi obviously places upon medicine the stamp of scientific approval as well. Reverberations of discussions amongst medical men as to whether medicine is art or science may even have reached your ears. We can, however, at the outset with the greatest candor admit that in the relatively short span of years during which time medicine could lay any justifiable claim to being a science, only during this time has palpable progress been made in the healing art. It is to the steady growth of knowledge and science on a broad base and to the more general employment of the scientific method in the solution of its problems that medicine owes whatever distinction it enjoys.

My responsibility on this occasion is to present the rôle that surgery plays in the treatment of disease. Time was, not so long ago, when little of surgery was deemed scientific. Lord Moynihan relates that as recently as 1800 when following several refusals, a charter was granted the disbanded company of surgeons of London, Lord Thurston is reported to have said in the House of Lords, when the bill had succeeded in the Commons: "There is no more science in surgery than in butchery." To this invective, Mr. Gunning, a surgeon, appropriately replied: "Then, my lord, I heartily pray that your lordship may break his leg and have only a butcher to set it."

Surgery or chirurgerie is a derivative of two Greek words which literally translated mean hand work or handicraft. A surgeon may then be defined as a manual laborer in a Greek dress. Representatives of the guild of surgeons have not infrequently been rash enough to speak of the art of surgery and one of our distinguished contemporary votaries has been so bold as to describe surgery, "The Queen of the Arts." Now one need not gossip much in the medical "sewing-circle," the confessional in which the sins of one's neighbor are adequately confessed, to learn that surgeons are not universally held in the high esteem to which we may pretend. Very few institutions of human invention have departed so little from the original spirit of the founder as the sewing-circle. There, we may find and hear ourselves scornfully described as carpenters and mere technicians. It would perhaps be a little unjust for us to take offense at the reproach implied in this designation, for many of us find in the artistry of work well done considerable satisfaction and we are not sensitive or ashamed over employing our hands in the service of our brains. So, whether a surgeon be a tradesman, an artisan or artist is apparently a matter of divided opinion. It is interesting, however, to reflect that whatever of ancient medicine has lived and proved useful in our day is essentially surgical in origin. Whereas, in the time of Hippocrates, medicine and surgery were one and the same healing art,

* A lecture sponsored by the Minnesota Chapter of Sigma Xi, January 31, 1936.

when we again hear of them after the turn of the twelfth century, surgery has assumed the servant rôle of handmaiden to medicine.

And thus, well into the middle of the seventeenth century we find medical men divided into three groups: the superior physician attended and prescribed for patients and with others of his kind concerned themselves over theoretical and abstract philosophic exercises relating to disease but of which they made very few accurate or careful observations and knew in consequence but little. At the lower end of the scale was the barber-surgeon or the surgeon of the short-robe of whose duties the present barber-pole is symbolic. He shaved the monks and bled them usually five times a year. In civil practice when blood had to be shed in the performance of an urgently indicated cutting operation, the barber-surgeon did it. He was wholly unschooled save for the knowledge and skill he acquired in the apprenticeship of his calling. He was usually an itinerant, finding it occasionally more convenient to his personal safety to be at some distance when the patient did poorly following his desperate acts of mercy. In the middle, between these two groups, equally hated by both, was the surgeon of the long robe whose essential duty was that of dressing and treating wounds. Eventually the surgeons strengthened their band by taking into company the barber-surgeons. It is a matter of common admission that in Queen Elizabeth's time when consultations were held between physicians and surgeons that the latter frequently awaited the decision of the physicians outside the sick room as to whether the services of the surgeons would be needed. Oh what mockery and deception there was in the ostentation of learning displayed by these pompous pedants, the physicians. Moreover, their hypocrisy has been fully avenged in that no tangible good of their deliberations has survived the wreck of time and descended to our day. Little wonder that Sydenham, a more modern Hippocrates, counselled "Don Quixote" as the best text on medicine of his time. When Boerhaeve, one of the most illustrious and distinguished physicians of the eighteenth century, died he left behind him an elegant brochure, the title page of which declared that it contained all the secrets of medicine. When the volume was opened, every page except one was blank. On it was written, "Keep the head cool, the feet warm and the bowels open." This legacy of Boerhaeve to suffering humanity was the product of blind adherence for centuries to authority influenced only by theoretical philosophical abstractions.

O Clio, Muse of history! May it never again be your duty to record in the annals of medicine that men have disdained the skill of the hand and the observations of the eye as being unworthy of the attention of men of learning. May medicine always remain free from the fetters of tradition and authority and the philosophic exercises of the mind uninterested in ascertaining what is fact.

THE DEVELOPMENT OF SURGERY

To attempt to tell you in sixty minutes of how surgery has benefited man through the centuries is admittedly a difficult task. My duty is somewhat lightened, however, in that up until about sixty years ago the chief anxiety of surgery was with the treatment of wounds. In the intervening years, surgery has emerged from a handicraft concerned with wound management to occupy

an important position in the treatment of disease. It is with this latter significant chapter of surgery that we are here concerned. Before reviewing some of the accomplishments of surgery attained by modern methods, let us briefly peep into the common practices prevalent well up toward the middle of the nineteenth century.

Anesthesia and asepsis were unknown. Bacteriology had never been heard of. Of the Hotel Dieu the great municipal hospital of Paris and probably the oldest hospital in existence in the world, Warren writes:

> "In the surgical ward there were, on January 6, 1776, 273 patients, there being but 106 beds in the ward. The walls were soiled with expectorations and the floors with evacuations of the bowels and bladders, as also with blood and discharges from the wounds. The wood-supply and the washing were kept in this ward, and every afternoon there was also an out-patient clinic. There were four rows of beds in a ward 34 feet wide, and the report states: 'It is difficult to maintain the purity of the air on account of the blood and pus that stain the floor, which it is impossible to clean, owing to the crowding of the beds.' (Tenon's Committee.)
>
> "In the St. Jerome Ward more operations were performed than in any other ward in Europe. It was placed almost directly over the dead-house, the odors of which were quite perceptible. This ward accommodated about twenty beds and an out-patient department. The capacity of the hospital was 2,500 beds, but during the cold season as many as 4,800 patients were in the hospital at one time. On the straw beds there were sometimes four or five patients called 'agonisans.' These patients were not only the moribund, but also those whose sphincters were beyond control. These beds were only occasionally wiped with a cloth, and the straw was rarely changed. On extraordinary occasions the patients were placed in tiers one above another, so that some were reached only by a ladder. There were no stoves, the wards being warmed only by the presence of the patients."

How the world has moved on since that day, not only in things medical but in the art and knowledge of sanitation, plumbing, heating, ventilation, architecture and a score of other matters which bear directly upon the comfort of hospital patients. The growth of science has created wealth, convenience and luxury—much of which we can all enjoy. This picture of a hospital scene was probably not overdrawn and was likely fairly typical of what prevailed where patients were brought together in groups until antiseptic practices revolutionized surgery.

The only operations performed were those of necessity—to save life and when pain was no longer tolerable, as in the presence of a stone in the bladder. In the cutting for the relief of this disorder, the surgeons of the day had developed considerable proficiency. The bladder would be sounded to make certain of the presence of a calculus. The lithotomist would make an incision in the perineum and in a minute he would exhibit the extricated precious stone. Speed was the primary consideration. Amputation of an injured or mortified extremity was another operation which the surgeons had learned to do with

dispatch. The lightning-like swiftness of these men in their work has been the object of constant marvel. I have been told of a surgeon of the pre-anesthetic era who in his rash haste in the amputation of a thigh removed as well two fingers of his assistant and both testes of the patient—all in the space of twenty-six seconds! Since the time of Ambrose Paré (1552), the employment of the ligature in amputations for the control of hemorrhage had become universal practice. Before, the flow of blood from the extremity had been staunched by the use of heated irons, it being hoped that the arrest of hemorrhage would occur through the clotting of the blood in the seared vessel.

War played an important rôle in the development of early surgery. Crude and imperfect as were obviously the ministrations of the surgeons of this time, their services on the battlefield were held in high esteem by kings, generals and soldiers alike. The examples of Ambrose Paré and of Barron Larrey afford striking illustrations of the happy influence which the military surgeon of an earlier day exerted over the minds of soldiers in time of war, inspiring confidence in their leaders and assuring them of greater security and safety when struck down by accident or disease. When the French surgeon Paré appeared at Metz, the soldiers of Charles V, exhausted by fatigue and hunger, crowded around the great surgeon exclaiming, "We have no longer any fear of dying even if we should be wounded, Paré our friend is among us." And Larrey, who accompanied Napoleon through all his campaigns, was loved by the soldiers and Bonaparte declared him the most honest and upright man he had ever known. Larrey must have been a most kind and thoughtful man, yet, perusal of his books affords no description of the untold suffering borne by these men during operative procedures. On one day he amputated more than 200 limbs upon the field of battle—all without anesthesia. How he and his soldiers must have steeled themselves for such ordeals. More than a century earlier Paré had expressed the opinion that surgery, though perhaps incomplete, had attained to a state of perfection, unlikely ever to be improved upon. Vain man has again, from time to time, uttered such futile and frivolous prophecies, only to be in turn outdone and humiliated by his successors.

ANESTHESIA

The horror of an operation without the beneficent agency of anesthesia is terrible to contemplate. Very few persons are probably now alive who were eye witnesses to such distressed scenes. The advent of administration of ether for the alleviation of pain, an American invention by the dentist Morton in 1846, was one of the great medical triumphs of all time. At the scene of its first supervised trial at the Massachusetts General Hospital in Boston on October 16, 1846, John Collins Warren, the operating surgeon, on conclusion of the successful experiment spoke those prophetic words, "Gentlemen, this is no humbug."

Never in the history of medicine has a therapeutic principle been so quickly put into practice. Man had long hoped for such an antidote for pain but it had seemed to be alone a celestial blessing not to be attained in an earthly existence. Oliver Wendell Holmes, our physician-poet, for whom medical men

in particular have an especial affection, coined the word anesthesia (without feeling). And so the excruciating pain of operation was steeped in oblivion to remain only upon the scarred memories of sufferers and witnesses. Opposition was encountered in the introduction of anesthesia in Scotland, where Simpson in Edinburgh advocated the use of chloroform to assuage the pain of childbirth. Scotch theologians of the stamp of John Knox proclaimed from the pulpit that the pain of childbirth was a punishment to be borne in the spirit of meekness and that the administration of anesthetics was an irreverent attempt to circumvent the mandates of the divine power. Scripture was freely quoted in the support of this contention. It has been related of Simpson that he would have given both his Bible and his Shakespeare for a copy of Oliver and Boyd's fact-containing almanac, yet he knew his Bible, too, and used the same weapon in defense when he referred his opponents to the 21st verse of the second chapter of Genesis, "and the Lord caused a deep sleep to fall upon Adam and he slept and he took one of his ribs and closed up the flesh thereof." Simpson eventually triumphed and when Queen Victoria permitted the use of chloroform at the time Prince Leopold was born in 1853 all opposition broke down.

HOLMES AND SEMMELWEISS AND THE CONTAGION OF PUERPERAL FEVER

Considerable impetus was lent to surgery in the development of anesthesia. Patients more willingly sought relief from disorders which threatened life and operations became more frequent. Apart from the obliteration of the pain factor during operation, permitting of greater care and deliberation on the part of the surgeon, the results were the same. Wounds suppurated; blood poisoning, erysipelas and hospital gangrene followed the surgeons about and thwarted their every effort. The mortality of even trivial operations was prohibitive. It is related of Sir Astley Cooper, the most celebrated surgeon of his time in London, that when requested by King George IV that he remove a simple wen from the King's head that his agitation knew no bounds. Cooper's anxiety and fear lest erysipelas should supervene seem scarcely compensated by the baronetcy which the King bestowed upon him as a reward for the successful issue of the operation.

Sepsis was the curse of surgery. The forecast that surgery had reached its zenith was more frequently heard from authoritative persons. Suppuration was apparently a natural and unavoidable sequence of operation. When the evidence of inflammation was limited to the site of operation without the menacing portent of centripetal spread, the appearance of an abundance of yellow exudate was acclaimed as "laudable pus." Nicholas Pirogoff, a Russian military surgeon of many campaigns who had numberless occasions to feel the futility of his own art in dealing with suppuration, was moved to write a dissertation upon "Fortune in Surgery" in which he stated that "the influence of the surgeon, the therapeutic resources and mechanical dexterity are of no importance; the results of an operation are dependent entirely upon chance."

However, even before Pirogoff made this resigned pronouncement, Oliver Wendell Holmes had squarely put the blame upon the doctors themselves—at

least as far as the tragedies of suppuration attending child-bed fever were concerned. The disease known as puerperal fever he said in 1843 is contagious insofar as it is carried from patient to patient by physicians and nurses. The storm of protest and resentment provoked among physicians can be readily imagined. The doctors Hodge and Meigs, professors of obstetrics in Philadelphia, took largely upon themselves the defense of the innocence of physicians in such matters. The denunciation heaped upon Holmes were multiple.

Let us for a minute examine Holmes' seriousness. He said:

> "Let it be remembered that persons are nothing in this matter, better that twenty pamphleteers should be silenced, or as many professors unseated, than that one mother's life should be taken. There is no quarrel here between men, but there is deadly incompatibility and exterminating warfare between doctrines. . . . If I am wrong, let me be put down by such a rebuke as no rash declaimer has received since there has been a public opinion in the medical profession of America; if I am right, let doctrines which lead to professional homicide be no longer taught from the chairs of those two great institutions. Indifference will not do here; our journalists and committees have no right to take up their pages with minute anatomy and tediously detailed cases, while it is a question whether or not the 'blackdeath' of child-bed is to be scattered broadcast by the agency of the mother's friend and adviser. Let the men who mould opinions look to it; if there is any voluntary blindness, any interested oversight, any culpable negligence, even, in such a matter, and the facts shall reach the public ear; the pestilence-carrier of the lying-in chamber must look to God for pardon, for man will never forgive him."

Holmes was not certain of the manner in which this pestilence was carried. His views may be summarized as follows:

> "I shall not enter into any dispute about the particular mode of infection, whether it be by the atmosphere the physician carries about him into the sick-chamber, or by the direct application of the virus to the absorbing surfaces with which his hand comes in contact. Many facts and opinions are in favor of each of these modes of transmission. But it is obvious that in the majority of cases it must be impossible to decide by which of these channels the disease is conveyed, from the nature of the intercourse between the physician and the patient."

In 1847, Semmelweiss, a twenty-eight-year-old assistant in the obstetrical clinic at Vienna, saw in a post-mortem wound of the finger sustained by his friend, Kolletscha, at the necropsy of a parturient woman, which caused his friend's death with findings similar to those observed in women dying of child-bed fever, a source for the contagion. He asked the students who participated in post-mortem examinations to wash their hands in chloride of lime before aiding with the duties of the lying-in chamber. Semmelweiss quickly demonstrated to his own satisfaction and that of some of his colleagues that the contagion was carried directly upon the hands of the attendants. Youth must bear its yoke. His superiors refused to take any notice of his claims. Impetous

and intolerant of criticism, Semmelweiss directed his energies into channels which led to his dismissal with lost opportunity. His earnestness is certainly to be admired. Said Semmelweiss:

> "Should the professors not soon consent to have their medical students and internes instructed in my methods; should the administration continue to tolerate the epidemics of puerperal fever in the hospitals, I will direct myself to the public in order to secure proper protection for those to be confined. I will say: 'Father of the family! Do you know what it means to call a medical attendant for your wife at childbirth? It means that you put a hazard to life in the way of your wife and unborn child. If you do not wish to become a widower, and if you do not wish your unborn child injected with a lethal poison, and should your children not wish to lose their mother, go buy yourself a little calcium chloride; pour a little water on to dissolve it, and do not permit the physician or the midwife to make an internal examination of your wife until they have carefully washed their hands in the chlorine water. But do not blame the physician or the midwife for this threat to your wife's life. The responsibility lies with the professor of obstetrics who taught them and who failed to indicate that the resorption fever may be avoided by preventing infection from without. . . . I hope that the public will prove more capable of being instructed than the professors of obstetrics.'"

Prophets have been stoned in places other than Jerusalem. Sammelweiss has already lived longer in his name than in his body, a distinction which most of us shall not achieve. When futurity has antiquated the present, time will still smile kindly on the courage and glory of this man whom her contemporaries ignored. Their curses have long since ceased their din upon his ears. We need the example of men like Semmelweiss more than they need our praise.

ANTISEPSIS

Working quietly but feverishly in his laboratory in France was a chemist, Louis Pasteur, the medical Moses who was to revolutionize medicine and surgery and lead it out of the bondage and fear of suppuration. Life had confronted him with a number of practical tasks. With a genius for taking infinite pains, he had been able to solve the mystery of tartaric acid by demonstrating the presence of two tartars with the same chemical formula—one with laevorotatory, the other with dextrorotatory behavior towards a plane of polarized light. In turn, he discovered that micro-organisms were the cause of the spoiling of beers and wine, and that a parasite was responsible for the catastrophies in the silk industries of southern France. These studies led him into an investigation of the nature of chicken-cholera, anthrax and the general problem of infection. He crushed for good and all the doctrine of spontaneous generation and his successful vaccination of hydrophobia crowned his achievements. This man of humble origin did his best work after he had been stricken down with apoplexy at forty-six. Fortune dealt kindly with our medical Moses, for he lived to get more than a glimpse of the promised land from Mount

Pisgah. He crossed the Jordan and when he died in 1895 the world acclaimed him as the greatest public benefactor of all time. He had kept the covenant.

The torch lit by Pasteur was to burn brightly in the hands of Lister, our surgical Joshua. He it was who, by the application of antiseptics to the skin, demonstrated that incisions could be made and that wounds would heal without the anticipated consequence of suppuration. For centuries inflammation had continuously harassed the surgeons and frustrated their efforts. It is not amazing, therefore, that this new prophet, though his divinations were true, like Cassandra was not believed. The walls of age-long prejudice were not to topple and fall like those of Jericho. The exultant shout of victory over all opposition was delayed well up toward the close of the last century.

THE NEW SCIENCE OF BACTERIOLOGY

In brief, this is the story of the origin of present-day surgery. The microscope and the employment of aniline dyes taught us in the new medical science of bacteriology why wounds suppurated. Man then quickly developed technical procedures which have gradually made it possible to invade and attack diseased processes in every body cavity and almost every tissue. The growth of medical knowledge during the time which parallels the discovery and development of bacteriology has been unprecedented in the annals of medical history. An ever-increasing flood of illumination has penetrated into the mysterious darkness of disease. A small faint source of flickering light, in which one groped blindly about, unable to read or see the cause of disease had suddenly become incandescent and brilliantly bright. The lamp lit by Koch, the father of bacteriology, has continued to burn, but the light has not always been so luminous, and has been inadequate to permit of satisfactory vision in the dim recesses of many diseases.

Within a few years a score of bacterial diseases which had defied probing and understanding by the tedious, inexact and inaccurate methods of noting the symptoms present and the tissue effects produced, became clarified. The employment of a new approach to old problems had succeeded over night in differentiating with precise methods what centuries of speculation and plodding effort had failed to do.

The studies in pathological anatomy by John Hunter, Bichat, Laënnec, Louis, Baillie and later of Rokitansky and Virchow together with the contributions of physiologists of the mark of Johannes Müller, Magendie, Claude, Bernard and Helmholtz had greatly enriched the stores of medical knowledge, but these innovations had influenced the practice of medicine but slightly. To these anatomic and physiologic contributions the new bacteriological discoveries lent better understanding and increased importance; the results of previous morphological and physiological studies took on new meaning and their relation to the practice of medicine and as avenues for enlarging and extending the horizon of medical thought, became quickly apparent. The significance of the momentum afforded to already existing medical knowledge and the impetus lent to further exploration into the obscurities of medicine by the new science of bacteriology cannot be overestimated. Never before in the history of man had disease been seen and read with the crystalline clairvoyance

made possible by this new tool. Medical journals multiplied to record the successive discoveries and conquests. New approaches to obscure problems created new and unfamiliar specialties of practice and brought into being new sciences to assail disease in the interphases between chemistry, physics and mathematics. Never before had the yield been so plenteous and laborers for the vineyard came forward in numbers with their various talents for the harvest.

THE NEW SURGERY

The rôle of surgery in the elaboration of knowledge concerning disease has been an important one. The therapeutic triumphs over dread afflictions once believed to be beyond remedy have been manifold. To enumerate many of them here would be impossible and wearisome. It may not be out of place, however, to retell the story of some of these victories and to recount briefly the manner in which surgery works and attains its ends today.

It is very fitting that one of the first applications to which the instrument of the new surgery was put was the relief of suffering women. So much of the exhausting drudgery of the daily tasks of life and the painful misery of woman's lot is borne in silent complacence that one feels a sense of gratification in this chivalry, however accidental it might have been.

The first aggressions into the abdomen under the auspices of antiseptic surgery were directed toward the removal of ovarian cysts which frequently distressed and incapacitated women as much on accident of the size of the tumor as because of pain. Even before the days of anesthesia and antisepsis, however, Ephraim McDowell, a bold pioneer of the West, in 1809 in Danville, Kentucky, had succeeded in removing a large ovarian cyst from the abdomen of Mrs. Crawford. Eight times in thirteen trials success attended the fearless efforts of this intrepid surgical explorer.

In 1879 loyal admirers keenly impressed with the significance of McDowell's contribution erected a monument in his honor with the inscription, "Honor to whom honor is due." It is eminently just that within the past year a monument has also been erected in memory of the courage and resolute fortitude of the patient, Jane Todd Crawford.

The great pioneer work of Marion Sims in the aid of women, suffering from the presence of abnormal fistulous communications with bowel or bladder, which unfortunate accident occasionally attends precipitous childbirth, was notably accelerated and advanced in the hands of the new surgery. The surgeon became bolder and invaded the hitherto unexplored domain of the vermiform appendix, the large and small intestine—even excising diseased portions of the stomach. Simultaneously surgical attacks were directed with startling success upon concretions that formed in the gall bladder, kidney and urinary bladder, which had long been familiar and frequent causes of much human misery not susceptible of relief by ordinary medical measures. Even use of the hypodermic syringe employed in the administration of medicines to assuage the severity of such painful seizures was not without its attended dangers until asepsis became the vogue.

Technical developments grew apace and more drastic operative procedures requiring greater care and deliberation could be done without serious risk. In 1866 Samuel Gross had said that the danger of hemorrhage was so great in operating upon goiter that only a fool would be induced to try it. By 1880 partial excision of the enlarged thyroid for the relief of mechanical obstruction to breathing was a common occurrence in surgical clinics. With the development of cerebral localization—a product of experimental surgical research and refinements in neurological diagnosis which indicated that definite areas in the brain directly correlate with certain peripheral nerves—with this knowledge came successful surgical intervention for the relief of increased intracranial pressure caused by brain tumors. Tumors of the spinal cord and its coverings proved even more amenable to surgery. By 1906, knowledge concerning the incompatibilities of blood groups and the technical features of transferring blood from one individual to another had been sufficiently worked out that blood transfusion—a therapeutic agency which had been taken up and discarded many times in the preceding 250 years because of the fatalities attending its use, became a reality. Transfusion of blood had superseded promiscuous blood letting as a remedial measure. Developments in surgery have created a demand for elaboration of other anesthetic agents and today we have local, regional, and intravenous anesthetic agents as well as a host of vapors which may be inhaled to allay the pain of operation. Emulating the principle of looking into the eye by means of reflected light introduced by Helmholtz, endoscopic technique and instruments were quickly developed to look into practically every natural orifice of the body. With the aid of the X-rays, surgeons have recently developed methods of visualizing the urinary and biliary tracts by the introduction of a solution into a superficial vein. Surgeons have injected air into the spinal canal and ventricular system of the brain to afford the contrast in density which permits of better localization of tumors by the use of X-rays. Surgery of the extremities, no longer concerned itself alone with the removal of dead or dying tissue. Broken bones in which one of the fragments projected through the skin when treated in accordance with the precepts of Lister, now ceased to carry such a formidable threat to life. Operations upon the delicate and intricate structure of the eye, a branch of surgery in which Albert V. Graefe, even before the days of antisepsis, had performed works of wonder, repairing failing vision—such operations now became even more successful in the hands of many ophthalmic surgeons who were followers of Listerism. The power to work miracles had descended upon many disciples and in many lands, persons with dimmed vision were to be privileged again to know what a pleasant thing it is "for the eyes to behold the sun."

With the development of means of administering anesthesia by overhead pressure to combat the subatmospheric pressure normally present in the pleural cavity, the thorax, the last stronghold of the large body cavities to resist invasion of the surgeon, surrendered. And experience gained in the war has made the correction of deformities the special concern of the plastic surgeon.

In these pages I have occasionally described under the more inclusive caption of medicine the activities of the surgeon. The great growth of information in the biologic field has made it impossible for any one man to be equal

master of all the ramifications of medical knowledge and practice—let alone make any contributions to the patrimony of biologic science. The number of specialists in the medical field has now become so large as to impose a great task on anyone who should attempt to enumerate them all. The problem of relating and taking advantage of gains in skill and knowledge possessed by any of these groups by the others is obviously an intricate and difficult problem. Today divisions in practical medicine are based essentially on mastery of diagnostic and therapeutic agencies. The activities of the surgeon are no longer dictated by physicians who would limit their function to the care of wounds, ulcers, fractures, dislocations and operations of necessity. The surgeon has become a physician in the field of his interest. Today physicians and surgeons stand side by side not as master and servant but more as willing helpmates linked together by the bonds of a sacred duty combining different talents and responsibilities but similar interests in the care of the sick.

SURGERY THEN AND NOW

The contrast afforded in the preparation for and conduct of an operation in the pre-antiseptic era and that of present-day practice is startling. Then, surgeons washed their hands after operation instead of before. The surgeon took his instruments out of his case much as a plumber removes his tools from his kit. Without more ado, he put them out on the table, took off his street-coat, when in the hospital, donned a frock-coat which usually hung on its owner's hook in the operating room. The sleeves and other parts of this garb often bore too obvious traces of previous encounters with free hemorrhage. It was customary to put out only a pair of hemostats with which to close the mouths of bleeding vessels before they were secured with ligatures. Marine sponges taken from the same kit were put out on the table and were employed to sponge up the blood accumulating in the wound. The surgeon frequently carried his sutures and needles in the lapel of his operating frock. It was not uncommon practice for the surgeon to taper the thread in the manner employed by a seamstress who points the tip of the thread with her lips before attempting to pass it through the eye of the needle. Though Lister had addressed the International Medical Congress which met in Philadelphia in 1876 upon the subject of antiseptic surgery, his words fell upon deaf ears. Some of the most celebrated surgeons in the country, as a last gesture before the skin incision was made, continued to strop the blades of their knives on their boots or the heels of their shoes. Many a spectacular surgeon between cuts reposed the blade of his knife, pirate-fashion, between his teeth. Instruments accidentally dropped on the floor were replaced on the table for immediate use by any bystander. An interested spectator was occasionally asked to put his hand into the wound and examine the tissue under consideration. However dreadful and incredible these practices may seem to you now, it is even more strange to recollect that such methods prevailed among the most respected of the surgical profession in this and other countries until in the early eighties when the momentum of the precepts of Listerism crushed all opposition. Following the assault upon President Garfield in 1881, he was attended by two of America's

best known surgeons of the time, who together with the other medical attendants probed the bullet wound with their fingers and catheters. An antiseptic dressing was applied to the wound, but there is no suggestion that other precautions were observed to avoid infection of the wound. There remains but little doubt that these maneuvers and the failure to heed the warning uttered by Lister in this country five years before were of major consequence in bringing about Garfield's death somewhat more than two months following the receipt of the injury. Here and there, however, as late as 1900 the doctor refused soap and water for the cleansing of his hands offered him by the mid-wife, before going into the lying-in chamber, saying, "No, thank you, I washed my hands just before I tied up my horse."

The late W. W. Keen states that at the second battle of Bull Run he had charge of a caravan of thirty-six wagons of medical supplies. Eleven of this number carried only alcohol, brandy, and wine for the injured—indeed a very liberal portion of the medical supplies! We have no testimony that the generous internal administration of this remedy accomplished very much. Had that medicament been employed externally as the good Samaritan used it in binding up the wounds of the man who fell among thieves, "pouring in oil and wine," how many lives would have been saved. How this parable might have been cited for the instruction of surgeons as well as lawyers!

Lister believed that the danger lurked in the air and devised a carbolic acid dressing to exclude the putrefactive influence of the atmosphere and sprayed the operating room and the field of operation generously with a solution of dilute carbolic acid during the operation. It was soon learned that the air itself was the least important source of the contagion—that the patient's skin, the hands of the surgeon and his assistants; the instruments, linen and gauze must all be rendered as sterile as possible. Thermal sterilization quickly replaced the chemical. Participants in the operation donned sterile gowns and added the wearing of sterilized rubber gloves to meticulous mechanical cleansing of the hands for the added safety of the patient and finally it was appreciated that wearing of masks, covering mouth and nose, was highly essential in order to preclude droplet infection of the wound. Surgery, however, was not born full fledged like Minerva, the goddess of the handicrafts. From year to year new methods and techniques have caused surgery to exhibit improvement similar to that manifested in our motor cars over five- or ten-year periods.

A third-year medical student or a student nurse who has had the opportunity of witnessing operations, but whose hand has never poised a scalpel, would be a far safer surgeon than the best of that period, despite serious lack of experience and skill. The hospital with its present-day appointments is equally as changed as is the surgeon. A person in no small measure responsible for the improvement in its atmosphere is the nurse. The rôle of the nurse in the care of the sick and particularly of surgical patients is a most important one. When one contemplates the Betsy Prig or Sairey Gamp of Dickens' time, he cannot fail to recognize the extent of the reformation which has simultaneously occurred in nursing. The movement which Florence Nightingale set in motion in Scutari during the Crimean War for the aid of ill and injured soldiers will keep her memory bright forever. Only since Lister and Florence Nightingale have

hospitals become true havens for the sick. Before Lister, the patient accepted chances with no more promise than those afforded gamblers at Monte Carlo. Today the risk of almost every operative procedure can be reasonably gauged and the patient can decide whether the gain is worth the hazard.

The new surgery created and brought the modern hospital into being. Despite all our striving for uniformity and attempts at standardization, every hospital, as Harvey Cushing has so well said, has a personality all its own—an intangible quality; let us hope that is always an asset. This character represents usually a combination of individualities rather than individual accomplishments. To this fusion, all who have worked in the hospital, no matter how lowly his position, brings his contribution. The student nurses, their superiors, the orderlies, the clerical force, social service workers, students, house-officers, and staff—these help to mould the personality of a hospital—in which expression, Axel, the orderly, who takes pride in the giving of a fine enema, or Charlie, elevator operator who dressed the Christmas trees since the hospital was built and still comes back to discharge this function after retirement, and helpful Fred Hamilton, hospital engineer; the foot-weary instrument nurse who continues to pass hemostats to the less agreeable and somewhat imperious surgeon; the overworked, underpaid and faithful secretary who labors in and out of season without complaint to write the letters and type the papers of her chief; loyal assistants who lend patient and attentive ears to the inquiries of the sick and their relatives after a hard day's work in the operating room, and who still have energy and enthusiasm to pursue an investigation in the experimental laboratory in their few hours of leisure—these noble men and women who live and love their work and bring to their jobs their very best effort—they help to mould the spirit of a hospital as much as the senior staff or the hospital director who tells us how much money we may spend. The ward maid, anxious over the personal comforts of the patients of her charge, worries about the old man with the hip whom Doctor Cole operated upon yesterday and the baby with the cleft palate repaired by Doctor Ritchie. She wonders whether the window left open may have been the reason that John in 407 failed to recover from his operation. To the hospital superintendent falls the more important but less interesting task of worrying about the per diem cost. One may well, with the poet, inquire, "In the sweet ear of nature, whose song is the best?"

TRENDS IN SURGERY

Over and over again, time has demonstrated that the borders of medicine and surgery are not fixed but subject to constant change. We are continually striving to find means of treating surgically diseases which are refractory to medical management. At the same time, an uninterrupted and restless search is always on for more conservative agents which may adequately replace satisfactory but more energetic operative intervention. These imaginative pursuits and dreams of physicians and surgeons are often matters of stern reality to the patient afflicted with an internal disorder for which medicine can do nothing as well as to the patient faced with the prospect of operation for the relief of his complaint. The one asks, "May not an operation help me?" The other, "Can-

not the same result be accomplished without operation?" These two opposed activities of the surgeon—greater conservatism in the management of diseases already amenable to operative intervention; and aggression bordering on radicalism in diseases refractory to any known treatment—these activities are always in progress like the changes in a reversible chemical reaction.

We find the surgeon on the one hand excising a portion to all of the stomach or colon or removing an entire lung for cancer, extirpating the urinary bladder similarly affected and transplanting the ureters into the bowel, as well as entering the skull and removing generous portions of the brain when the seat of a malignant tumor; we find him removing almost all the ribs on one side of the chest in order to obtain mechanical compression for the diseased lung and stop the ravages of tuberculosis when bed rest and medical measures have failed.

We find him so bold as to excise liberal portions of the sympathetic nervous system to secure relief of pain and an improved peripheral circulation in patients with spastic contraction of their blood vessels where gangrene is threatening. This same rash endeavor he applies occasionally to physiologic spastic types of bowel obstruction and even constipation. And now we find him attempting to relieve the menacing threats of high blood pressure with its consequences by removing portions of the sympathetic nerves and the adrenal gland. No portion of the human anatomy seems to have withstood the force of his invasion. He is found removing small tumors in the pancreas that produce insulin in excess and cause its owner to have lethargy and convulsions—tumors whose presence had long been noted but which were generally believed to be without significance. We find him trying to revive patients who stand on the brink of death from the rare but appalling disaster of pulmonary embolism, in which a blood clot loosens during convalescence after operation and propagates itself as a thrombus plugging the pulmonary artery, making respiration ineffectual.

Mandl, an enterprising young surgeon in Vienna, solved the mystery of multiple bone cysts with associated parathyroid tumors which condition had long intrigued pathologists by excising a parathyroid tumor and arresting the diseased process. We find the surgeon now the strong right arm of the endocrinologist in attacks upon tumors of glands such as the adrenal, hypophysis, ovary and testis which affect body growth and development as well as personality. This romantic activity of the surgeon promises to be one of the most dramatic and fruitful of all his labors. My colleague, Doctor McQuarrie, will later elaborate the rôle of the surgeon in this most fascinating province of medicine.

At the same time, this intrepid and somewhat reckless fellow, the surgeon will be found injecting sclerosing solutions into varicose veins to obliterate them instead of excising them as he was wont to do a few decades earlier. We find him attempting to cure hernias as well as hemorrhoids by injection rather than by operation. Truly, the hypodermic needle threatens to be mightier than the scalpel in the treatment of many surgical disorders. We find him aspirating gas and fluid from the distended stomach and upper reaches of the intestinal canal by an inlying duodenal tube to afford relief of obstruction without operation; or clipping off portions of the prostate gland which projects into the bladder causing urinary retention in aging men.

Strange as it may seem to you, the surgeon often appears to find in the successes of these strategic lesser surgical triumphs, greater cause for rejoicing than in the more brilliant and colorful victories of bold aggression, for he knows that they are purchased with less risk to life and cost patients less apprehension.

UNSOLVED PROBLEMS

In addition to the anxieties, trials and tribulations of his work which tend to make of the surgeon a modest man, any inclination to vanity or pride is short lived, in that the surgeon is daily reminded of the many diseases for which his art can do nothing and in which he is but a passive spectator. The scourges of cancer and infection take yearly a large toll of lives despite the best effort on the part of physicians and surgeons. To be certain, the surgeon has his successes, but when he reckons his losses, he is dismayed to see how large the winnings of death have been. With the many attacks launched upon the problem of cancer from every approach, one may hope soon to hear that this stronghold of disease has yielded. Whereas, the precepts of Pasteur and Lister have made it feasible to explore practically every body cavity with impunity, when the surgeon is confronted with established infection, the problem is essentially the same as it was before the days of Lister. Virulent spreading infections are as dangerous today as then. The surgeon in dealing with infection can only incise a localized collection of pus as in an abscess or prophylactically prevent extension of infection into a larger space as is best exemplified in the early removal of an inflamed appendix. When infection is spreading, whether it be in the arm, the brain or the lung, the surgeon can only do harm by intervention and must resign himself to supporting the natural defenses of the body, of which my colleague, Doctor Bell, will later speak at length. The patient must grimly fight out the battle with the infection with little or no specific help from his surgeon. Ambrose Paré recognized the limitations of surgery; he said, "I treated him, but God healed him."

As one reads the expressed hopes kindled in the breasts of medical men by the rapid bacteriological discoveries of the eighties and nineties and the first few years of this century, he might be led to believe that a specific treatment would soon be available for every bacterial disease. Suddenly, however, the the triumphant exploits of the bacteriologist seemed to have reached an impasse and no new great victories have been won. Yet, it is to the development of bacteriologic and pharmacologic aids that we must look for more light in our fight upon infections. Much of what has been accomplished, in the eyes of the pre-Listerian era is as much a miracle as the granting of vision to the blind Bartimaeus. Asepsis is the birthright of the present generation of physicians and surgeons. We take a just pride in it, but until we have enlarged this heritage, how can we feel proud? We must look to our laurels for posterity will find no lasting satisfaction in our achievement and that she will greatly improve upon our possessions one may write down not as a prediction but as a foregone conclusion. Our accomplishment by contrast with that of our antecedents may entitle us to feel like Brobdingnagians, but that exhilaration

can be only short lived, for, by comparison, the achievements of our successors will prove us to be mere Lilliputians.

Buried in the literary catacombs of the volumes which occupy the shelves of our libraries undoubtedly lie suggestions which if properly synthesized and coordinated would shed luminous light on our unsolved problems of infection and cancer. Were these volumes to be more worn by use than by time, the likelihood of important discoveries through the conversion of known facts into ideas would be greatly enhanced. We must often wait patiently and long for the discerning dreams of a Joseph or a Daniel who will be able to make such syntheses or lead us by a path yet unknown, directly to the solution of such problems as those presented by cancer and infection.

THE ROLE OF EXPERIMENTAL SURGERY

How anesthesia and asepsis reformed surgery is a revelation; how in turn the new surgery improved medicine, afforded abundant opportunity for observation of diseased processes and supplied new methods of bringing relief to man suffering from serious bodily disorders are but natural consequences of that great stimulus. The most significant advances in medicine are now coming about through the employment of surgery in the experimental study and investigation of disease. The anatomical structure of organs could be studied upon the dead body, but how these organs function is only to be ascertained during life. The new surgery served this objective admirably, and played an important rôle in the development of our knowledge of digestion, the circulation, respiration and the function of the ductless glands. How Harvey by animal experimentation proved that the blood circulates, even before the rise and development of the new physics and chemistry, attests the great significance of the experimental method in the study of normal function. For centuries speculation had been rife as to what the relationship was between the heart, the lungs, and blood vessels. These disputations had only succeeded in complicating and confusing the issue. A few simple experiments in the hands of an accurate observer brought enlightenment that left no room for further argumentation.

How much sooner Lister would have succeeded in dispelling the cloak of ignorance had he employed the advantages of animal experimentation. John Hunter recognized the superiority of the experimental method over logic. To Edward Jenner, of smallpox vaccination fame, Hunter said, "Try the experiment, don't think." Rationalization too often proves deceptive, not because the logic is fallacious, but rather because the knowledge of the factual data bearing on the matter is incomplete or the initial premises themselves may be wrong. History has repeatedly taught how apparently sound reasoning and deduction have led us astray. If all the factual data bearing on an issue were known and available to the one attempting its rationalization, a logician who would take the time to become thoroughly acquainted with the subject under discussion could deliver a satisfactory and accurate answer to any question propounded him. Direct experimentation will always have an important place in all human activity. How speculation and vacuous arguments have retarded human progress. The crucial test of experiment deletes our textbooks of

medical and surgical barnacles and ancient errors that have been recopied for generations.

The few years which have run through the hour glass of time within the experience of the youngest of this audience have witnessed two innovations of experimental surgery that have brought life and happiness to thousands of homes throughout the world. In 1922, Frederick Banting, an orthopedic surgeon in London, Ontario, abandoned his practice, convinced that the internal secretion of the pancreas could be isolated by eliminating the confusing influence of the digestive secretions of the same gland. In his imagination, known facts were built into an idea. Within a few months, together with helpful colleagues, he had succeeded. His name has since become a household word to be cherished in gratitude in homes where insulin helps diabetics to live and lead more normal lives. To the hands and creative mind of the pathologist, George Whipple, experimental surgery furnished the means of attacking the problem of blood regeneration in anemia. What Whipple learned of the value of liver as a dietary measure in the repair of blood loss was put to practical use by Minot and Murphy. Today in consequence, persons afflicted with the hitherto invariably fatal pernicious anemia can, with the aid of liver, live normal lives. Only homes which lost a mother or father or other dear one a short time before this discovery was made can fully appreciate the blessings of this new knowledge denied them, but enjoyed by others.

Yet, we hear prejudiced people raising their voices against animal experimentation. In this and other municipalities there is a self-styled "animal rescue league" which takes homeless dogs off the street and asphyxiates those which are not claimed. What deception there is in this disguise—the voice of Jacob, to be sure, but the hand of Esau! To kill without purpose—no savage barbarism could be more cruel than this. When man no longer slays animals for food or clothing or holds them subservient to his will, the significance of truths learned in animal experiments will fully justify their performance for the protection and prolongation of human life. One of the most valued instruments in the relentless search for the cause and alleviation of disease is the experimental method. Matters of such vital importance to health and happiness cannot be left to chance. Biological research employing the scientific method must go on; its discoveries and benefits are available to all men irrespective of creed or birth or whether rich or poor; through its agency more lives are saved than all the wars of all the ages have thrown away. Like a divining rod, the experimental method wrests truths from nature, which would otherwise percolate for centuries through the slow filters of time.

THE FUTURE OF SURGERY

What of the future of surgery? Any child who can speak can ask questions which none of us can answer. Just now, endocrinology in its broad aspect, in which activity surgery plays an important rôle, seems to hold forth a promise almost equal to that of bacteriology of fifty years ago. Whether advances in surgery will be made at a snail-like pace or in rapid strides will be determined not alone by discoveries in medicine as a whole but by developments in general

biology and the physical sciences. The two greatest benefactions of surgery to man are in reality gifts of chemistry to surgery. To be sure, ether and nitrous oxide inhalations were mere chemical playthings of the lecture hall until surgeons demonstrated their great value in the relief of pain. The value of chemical antiseptics and asepsis in the prevention of infection were wholly unknown till empirical trial and the discovery of micro-organisms declared their true worth. Anesthesia made operations possible; antisepsis and asepsis have made them safe. Discovery of the X-rays by Roentgen and of radio activity by Becquerel and of radium by the Curies have been a great boon to medicine—gifts from physics. The new science of bacteriology was essentially an outgrowth of chemistry, microscopy (physics) and medicine. No man can, more like Francis Bacon, take all knowledge for his province. It is, however, still true that some of our most valuable and useful information in the warfare on disease is to be learned at outposts stationed in the interphases of activity between greater medicine and our biological and physical sister sciences. Only through the activity of alert eyes and minds scanning the horizon in these interphases will the great lag between discovery and application become a less common occurrence.

Surgery, long a parasite on the common stores of knowledge, now has its own contribution to make. Recognition of the importance of the experimental laboratory for all workers in the field of clinical medicine is rapidly gaining ground. We have been accustomed to hear that the hospital wards are the laboratories of physicians and surgeons. No accurate observations may be made there and occasionally significant rationalizations may be made from such observations; only in the experimental laboratory, however, may the factors which bear on the observation be varied and a true analysis of its significance be reached. The crucial test of direct experimentation will serve to avoid the pitfalls of rationalization on incomplete factual data. The pedantry of authority has given way before the testimony of fact.

The interests of greater medicine, I cannot believe, will be best served by the complete withdrawal of groups such as anatomists and physiologists into the tranquil detachment of scholastic seclusion afforded by their laboratories. The great stimulus of enthusiasm gained by daily first-hand contact with unsolved problems can scarcely reach them there. Amidst the arduous responsibilities of service and practice, Vesalius, Paré, Harvey, Hunter, Jenner, Laennec, Koch, and Lister, among the most illustrious men in medicine of all times, they still found time to prosecute fruitful researches. At the same time, the clinical investigator intent upon the diverting and time-consuming occupation of his daily tasks may awaken to find himself the victim of a circumstance which befell Commander Peary, who while together with his companions on one of his Arctic explorations, found after some days that while they walked eight miles a day on a sheet of ice, they were being carried back ten miles by the current of the water. The vitalizing influence of stimulating teachers and investigators is becoming more generally recognized as transcending in importance all other material wealth of medical schools and institutions. The most valuable possession of a university, said the late William Osler in an address to

medical students on this campus forty-four years ago, are the names of the inspiring teachers of its faculty.

The surgeon, one occasionally hears it said, is a calloused individual who places little value on human life. If those who think so could only know the anguish, despair, and self-reproach of the surgeon with a knowing conscience, who feels that something which he did or failed to do had a part in bringing an illness to an unhappy ending, how much more often the surgeon would be pitied than censured.

The reassuring expressions of grateful patients more than reward surgeons for the hours of haunting anxieties which it is their lot to bear. The irrepressible joy and delight of children once sick and now restored to normal living, the restoration of health to the weary and suffering through the benisons of surgery—these are the best paymasters of the surgeon and satisfactions which he cherishes in his memory as among the most worthwhile of life's treasures. With his preoccupation of mind the surgeon may not learn much of life; but he is privileged to hear from the lips of people from every walk of life and read often in their anxious and despairing faces what to them is most worthwhile. How much it is to be regretted that it is not in the possession but in its pursuit that the greatest value is put on health.

If advances in our knowledge concerning disease should make much of present-day surgery unnecessary, the surgeon would be the first to welcome such an occurrence. For despite the painlessness of operations, he sees in the distressed faces of persons about to come under the knife unexpressed fears relating to the anesthetic and the operation. How can he but wish that patients could be spared these anxieties? However much the surgeon may desire that relief could be afforded without recourse to operation, and however surgery may change with the developments in greater medicine, it is quite safe to predict that there will be always a need for the services of surgeons. The vermiform appendix with its bad anatomical arrangement, which man gives no sign of outgrowing, will when obstructed probably always need excision; congenital and acquired deformities will necessitate operation for their correction, and automobile accidents appear to supply a constant field of activity for the surgeon. Yes, there are diseases yet unnamed for which surgery will be necessary.

The surgery of the future will integrate itself more closely with the problems of the social order. Forward-looking man no longer labels the dissection of dead bodies as a sacrilege. He has learned that information secured therefrom redounds at once to his own gain. Anesthesia is no longer looked upon as an impious attempt to thwart divine will and the great significance of animal experimentation for the welfare of man is being more generally recognized and appreciated. Sterilization of the socially unfit, which would burden society with progeny of an undesirable kind, is certainly not far off.

Search for a fountain which would restore youth to aging men has not been an occupation peculiar to Ponce de Leons and the dreams of poets. Surgical explorers who have gone in this quest have met the same fate which befell Ponce de Leon. The death of persons in the prime of life from a defect in a single tissue, whose bodies are otherwise sound, is as wanton desolation of human life as the discard of a good automobile with a plug in its gasoline line.

The function of medicine and surgery appears to be rather with the prevention of and salvage from occurrences of this sort. Whereas more people live to be old, there appears to be no good proof that people live to be older. The conjoint forces of public health and pediatrics have largely done away with the scourges which decimated the lives of infants and children. Many more people, therefore, gain the crest of the bridge of life, but the mortality beyond, because of the enormous toll taken by the degenerative diseases of increasing age still continues.

Though we hear much said about the stress and tension of modern life and its causative relationship to premature death in the useful period of middle age, there is but slender evidence to indicate, in the main, that man will live longer if he rusts out than if he wears out. And the joys and satisfactions gained in the knowledge of work well done are numbered among the pleasures that will not be foregone. It is apparently no longer true that the equanimity of a Methuselah, whose only chronicle was long life, will assure longevity. After Methuselah had lived more than 400 years, an angel is said to have appeared before him with the suggestion that he build himself a house for he was yet to live more than 500 years more. The chronicler relates that Methuselah felt the promise not worth the effort. Raymond Pearl has observed, however, that nonagenarians and centenarians as a group are uniformly characterized by a calm and equable temperament. Old age creeps daily upon us and will not be deferred. We see his mark upon another's brow more readily than upon our own. There seems but little likelihood that man will ever succeed in prolonging life greatly beyond its period of usefulness. It appears to be a law of life that when vital energies wane, death is near. Having eaten of the tree of knowledge, was not man driven out of the garden of Eden, "lest he put forth his hand and take also of the tree of life, and eat, and live forever?"

The surgery of the future will continue to relate itself to man's needs so that men may lead more full, complete and useful lives, and greater numbers shall come to their graves "in a full age, like a shock of corn cometh in, in his season." Surgeons will strive to relieve suffering, to repair injuries and save life. And when life is only a burden and medicine can bring no relief, when the social order recognizes the right of the individual to release from such distress, he can be helped on to a peaceful sleep in which there is no remembrance of painful things.

CONCLUSIONS

No panoramic view of the benefactions of surgery to man are contained in these remarks. Rather an attempt has been made to indicate the manner in which surgery, once an heroic remedy for a desperate ailment and concerned largely with the management of wounds, has come to enjoy an important position in the treatment of disease. The history of surgery teaches the important lesson that a single fact evolved from accurate observation is of more utility than an entire system of speculative invention. Facts built into ideas by the creative power of imagination, that all-important coefficient of the mind, establishes truths, overthrows false doctrines, and destroys the tyranny and frost

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QUAERITE ET INVENIETIS*

P. D. STRAUSBAUGH

It so happens that more has been said about research during the past twenty-five or thirty years than in all of the preceding centuries. Prior to this period investigators made such startling and significant discoveries that the whole world was awakened by them, and then came the inauguration of the "ballyhoo" period of the twentieth century, and it became the fashion to talk and write about research. In fact, so much has been said that it is no longer possible to find English words and combinations of English words that have not been used at some time or other as a caption for remarks concerning research. Therefore I turn to another language for a suitable headline, "Quaerite et Invenietis," "Seek and ye shall find." This is a terse way of expressing the very essence of all research activity.

In our effort to stimulate interest in investigational work and to increase the number of research workers, we have held out all manner of inducements such as scholarships, fellowships, assistantships, honors, stipends, and degrees. We have publicized and advertised the results of research and attempted to attract the investment of increasing sums of money, either by institutions, government, or by private individuals and business concerns. We have organized quasi-priesthoods which are called associations of one kind or another, and which speak a sort of esoteric language little understood by the average business and professional man. It is not my purpose to decry all this as useless activity nor to set up any claim that the aims and functioning of such activities are not valid. However, I wish to point out that our zeal for the development of research, expressed in this way, has given to the student and to the average man as well a very wrong idea of research, and I want to make a definite attempt to correct the misconception.

In the eyes of the student, particularly the more advanced student who has aspirations of higher achievement, there is a halo about the head of the research worker; he stands out as a man apart. The very name "research" connotes something of the mystical, something of the Divine gift reserved for the favored few, and the student confronted by this alluring vision wonders if he, too, is to become one of the chosen. I have known some individuals in the field of research who by assuming a certain air of dignity and omniscience, seemed to think it imperative that nothing should be left undone that would aid in the encouragement of such an illusion. Fortunately, however, our greatest contributors, our most fruitful research workers, are great-souled men and women, full of human understanding and sympathy, who regard themselves not gods or demigods of science, but the humblest servants of mankind. In this attempt to disillusion the student and all others who have entertained some false notions about this humble servant, I want to divest him of his halo, his academic honors, and all of the accompanying gold braid; I want to depict him as he really is, and to understand him for what he is.

* A lecture delivered before the Sigma Xi Club of the West Virginia University.

I have said that the epitome of research is expressed in my subject, "Seek, and ye shall find." Therefore if we will analyze this subject and see what it contains, we may arrive at a better understanding of what research is, and a more accurate conception of the research worker. To *seek* means to inquire about something, to look for or hunt for something. It does not involve mere wondering about things or day-dreaming; it means an active, determined, directed search for something. Now it will be readily recognized that the act of searching implies the existence of certain attitudes and the operation of certain mental processes. In the first place the act of seeking is motivated by curiosity. If the mainspring of curiosity is lacking there will be no inquiry. Only the boy who is curious about the working of a machine ascertains what makes the wheels go round. However, if curiosity is to result in vigorous inquiry it must be reinforced by the will to know. Idle curiosity may be a pleasing mental state but only a live, eager, impelling curiosity supplemented by the will to find out, can sustain the spirit of inquiry.

But inquiry must be directed; it must follow carefully chosen paths and must be ordered by fruitful and well-proved methods. The methods and course of inquiry will depend largely upon the experience of the inquirer, and the devising and selecting of methods requires both imagination and judgment. The lively imagination will find numerous ways of making an inquiry while the stolid mind may have no suggestion to offer. But among the numerous ways that may be devised some will be more effective than others, and the selection of the most fruitful ways and means requires the rôle of clear thinking and good judgment.

And finally our seeking requires observation and manipulation. We must observe carefully states and conditions, characteristics and changes. We must resort to controlled experimentation to find out the rôle of different factors, and what happens when the operation of these changes either quantitatively or qualitatively. Such observations and manipulations are capable of training, and the relative accuracy of the results obtained will depend largely upon the skill acquired in the experience of the inquirer. Likewise this experience determines in large measure the scope of the field in which inquiry may be carried on successfully, for it will be readily understood that this field is larger for one trained in the use of the microscope than for one who knows only how to use a small hand lens.

And so we see that seeking or searching involves (1) curiosity sustained and activated by the will to know; (2) imagination controlled by judgment; and (3) observation and experimentation. These potentialities are the possession of every normal man and woman. It follows, therefore, that every such individual possesses the tools necessary for the business of inquiry, and is engaged to a greater or less extent in carrying on actual research.

The greatest body of research workers, or perhaps I should say the busiest, most aggressive inquiries are the children. The intensive, driving unquenchable curiosity of children makes them natural incessant research workers, and every new situation is a subject for investigation. If this insatiable curiosity plus the indomitable energy of childhood could be maintained unabated throughout life, our achievement would be far greater than it is. Somehow or other

through the influence of the frequent impatient "don't" of parents and the various conformities required of them by our educational system, children tend to become imitators but not thinkers; spontaneous curiosity is dissipated and and the inquiring mind becomes merely an inquisitive mind. Thus by the time the individual enters college he conceives his task to be the acquiring of grades, credit hours, eventually a degree—and then, perhaps, a job. If in some way our educational program from the very beginning could be made to contribute more toward the development of the inquiring mind, the total result of our efforts would be much more encouraging, and scholarly achievement would be greatly augmented. Likewise for the tudent who engages in the conquest of knowledge equipped with an inquiring mind, there can be no drudgery for his course becomes one of high adventure filled with all manner of challenges, vigorous attacks, and thrilling victories.

You are doubtless familiar with the oft-quoted story of how James Watt's playful toying with a kettle in which boiling water was being converted into steam that caused the lid to alternately rise and fall, gave him the idea of the steam engine. Arago says, "The little James before the tea-kettle becomes the mighty engineer preparing the discoveries which were to immortalize him." This, of course, is a mere flight of fancy. There is no reason to suppose that the mind of the little James was occupied with philosophical considerations on the condensation of steam. However, the story does reveal something of the curiosity of the lad, and at the same time the characteristic manner in which parents and adults are too often wont to suppress this urge to inquiry. We are told that his aunt, observing his activity, reproved him for his indolence; "James Watt," said the worthy lady, "I never saw such an idle boy as you are; take a book, or employ yourself usefully; for the last hour you have not spoken one word, but taken off the lid of that kettle and put it on again, holding now a cup, and now a silver spoon, over the steam, watching how it rises from the spout, catching and counting the drops it falls into; are you not ashamed of spending your time in that way?" Curiosity may survive such reproof but certainly encouragement is a much better fostering influence.

Another universal attribute of children is the possession of a lively imagination. Those of you who follow, as I do, the adventures of Dicky Dare, have occasion frequently to recall some of your own adventures and experiences encountered in the realm of childhood's imagination. Although we often smile at the pictures which imagination paints, let us not think of this function too lightly nor dismiss it too hastily. The power of imagination is really one of our greatest assets and perhaps the trouble with most of us is that we do not exercise it sufficiently.

In the simplest and most common experience of each one of us, imagination is functioning constantly to furnish the most plausible explanation of situations, incidents, and facts of which we become aware through the medium of the senses. For example, if while driving my automobile I suddenly discover that I have a flat tire, I shall begin a lively search for some explanation of this occurrence. First of all I shall probably imagine that the tire was punctured by some sharp-pointed object such as a nail or tack. Following up this suggestion, I shall probably make a careful examination of the tire to see if I can

find any evidence of the presence of such a puncturing agent. If I chance to find a tack sticking in the tire, my hypothesis will be confirmed. However, if I find nothing of this sort and a careful examination reveals no break or opening in the tire, I shall have to abandon my first hypothesis. I shall now have to make another guess, *i.e.*, formulate another hypothesis. Such hypotheses are being formed constantly to explain the phenomena which we encounter in the most ordinary affairs of everyday life.

We see then that hypotheses are not revelations; they do not come to us from the world outside through the medium of sense perception. They are formed by the mind; they are the creations of the imagination. "A good theorizer, like a poet, is in a certain sense *born*, not made." The man who never has a "hunch," to whom "nothing ever happens," whose intellectual processes know no fire, color, or quickening of the imagination, will never likely make any significant discoveries. The spark of imagination flashing through the mind of scientific genius, and igniting insight closely akin to what we sometimes call inspiration, is the keen discovering power that has given us our important scientific theories. Of course, we realize that imagination must be directed; not even the creative genius of science can afford to neglect the facts. But controlled by critical observation, the scientific imagination attempts to devise or discover some law or principle that will, in some measure at least, serve to correlate and explain the facts of experience.

In Tyndall's essay on "The Scientific Use of the Imagination" he says: "With accurate experiment and observation to work upon, imagination becomes the architect of physical theory. Newton's passage from a falling apple to a falling moon was an act of the prepared imagination. Out of the facts of chemistry the constructive imagination of Dalton formed the atomic theory. Davy was richly endowed with the imaginative faculty, while with Faraday its exercise was incessant, preceding, accompanying, and guiding all his experiments. His strength and fertility as a discoverer are to be referred in great part to the stimulus of the imagination. Scientific men fight shy of the word because of its ultra-scientific connotations; but the fact is, that without the exercise of this power, our knowledge of nature would be a mere tabulation of coexistences and sequences."

Finally, children are great observers and experimenters. I need not dwell long on this point for all who are familiar with children can supply their own illustrations to prove the statement. From the boy Tommy Edison trying to incubate a setting of hen's eggs by sitting on the box in which they were contained, to Roscoe Myers riding a bicycle either forward or backward while facing either toward the front or the rear of the machine, through the unending variety of the stunts and feats performed by children, one sees this innate tendency to indulge in experimentation.

In attempting to show that the mental attitudes and operations inherent in all research activity are among the endowments of children, I intended to show that there is nothing unusual or mystifying about research; it is merely the seeking for new knowledge or new truth by the use of certain mental attributes common to us all. From the earliest dawning of individual consciousness to the end, we are constantly engaged in research activity. If, as students, we

could grasp and use the idea that the work of all education is a research program for each one of us, such an understanding and the effort that would grow out of it would make the entire process of education very different from what it now is.

After all it is not the mere content or final end product of research, valuable as this may be, that is of maximum importance. The all-important thing is the influence wrought in the mental fabric of the seeker. Invigorating encouragement and inherent activation of the research spirit throughout our entire educational program will insure the greatest returns in creative achievement. We should never lose sight of this promising potentiality. There may be in this very audience tonight the future Robert Brown, the future Pasteur, the future Madam Curie, the future Erwin Smith, the future Lord Kelvin, or the future Emil Fisher. If there is in the mind of youth a thoroughly live spirit of research, no one can foresee the limits of their achievement or what may be the fruits of their labor within the brief period of the next twenty or thirty years.

But do not misunderstand me; simply because I have stated that we are all engaged in research, it does not follow that we may all achieve in equal measure. In all of our undertakings we must realize that our total stock consists of two items: (1) What we have inherited and (2) what we have done with our inherited potentialities, or the training we have enjoyed. Since our inheritance is not the same, and since our training is different in each individual case, it follows that our achievements will vary accordingly in both quantity and quality. And as our mental powers, like our physical powers, may be improved through use, it follows that our efficiency in research will be improved correspondingly. Our first research activity will contribute entirely and solely to our own fund of knowledge and the enrichment of our own personal experience, because we are very likely to be active within the limits determined by the efforts of all those who have been active before our time. In other words, the accumulations of experience must be or usually are investigated first, and upon this experience the seeker builds the plans and programs for his further conquests. After we have once mastered some field of knowledge so completely that we are in a position to extend our inquiry beyond the present limits of the already known within that field, our discoveries—if there be any—will then make contributions to the field and thereby the limits of the known will be extended. The term "research" is too often confined to this last level of inquiry, and thus the word comes to have a too restricted meaning. As I have tried to indicate, research is a continuous process throughout life, and the total quantity of work done as well as the depth and quality of it will depend on the stock of the individual and the environment in which he works.

To be sure, the student who possesses a superior mind and who has received a thorough education; who has the means to carry on research unperturbed by anxiety regarding the high cost of living, or the funds necessary to provide either materials or needed assistance, has a decided advantage over those less well equipped. However, the spirit of research is irrepressible and unconquerable, and the seeker of truth knows no handicaps. Fired by this spirit the research man becomes unconscious of both mental and physical limitations. After he became partially paralyzed Pasteur continued his investigations, carry-

ing out an extended series of the most exacting experiments. And we must not forget Charles Proteus Steinmetz, "that strange, misshapen genius" whose brilliant mind helped to chart a successful course for the General Electric Company. In spite of his marked physical handicaps and deformities he was a mental giant.

Thus we see that the research worker is not one who has received a special revelation; he is an ordinary human being who through his earnest seeking for knowledge has developed his searching abilities. He exemplifies the sureness of the promise in Holy Writ: "To him that hath shall be given." If anyone entertains the idea that research involves intricate, difficult, complicated thinking, he will not find such a notion in accord with experience, for great and prolific ideas are almost simple ones. If anyone thinks it possible to spend four years in college accumulating a sufficient number of credit hours to entitle him to a diploma, and then to top off with three years of graduate work that will make of him a research man, that individual is laboring under a serious delusion. Such an individual may be granted a Ph.D. degree but he will never become a prolific research worker for he has missed the mark entirely. Only the honest, diligent, persistent seeker can hope to develop into the fruitful investigator.

There is another misconception that I should like to eliminate from the minds of some students, and that is the false notion that to make a success in the field of research it is necessary for one to have had the advantages afforded by birth in a wealthy or scholarly family. This is not true, for biography reveals that able contributors in the field—like presidents—have been derived from poor and rich homes alike—from the family of the plebian as well as from the family of the patrician. Michael Faraday was the son of a blacksmith. He began life as an errand boy for a bookbinder and stationer to whom he was later bound as an apprentice. Von Helmholtz and Lord Kelvin were sons of professors. Gregor Mendel was born in the home of a peasant and Pasteur was the son of a tanner. It may be of special interest to West Virginians to know that Robert Koch was the son of a miner. Haeckel was reared in the home of a government official and Agassiz was the son of a clergyman. Von Baer was derived from the family of a landed member of the German nobility, Von Liebig was the son of a dealer in dye stuffs, and Darwin was the son of a physician. This list could be extended indefinitely and everywhere it reveals clearly that what is called genius does not depend upon wealth or circumstances; it originates in inheritance and is cultivated by earnest effort. It has no essential relationship with "blue blood"; in fact, there are those who claim that it is more likely to occur as a result of racial mixture. Rafinesque would surely be a proof of this claim for he was the son of a Franco-Turkish father and a Graeco-German mother.

I have already indicated that college attendance is no assurance of preparation for success in research work. I may now add that college training is no *sine qua non* for the development of a research career. Wilhelm Hofmeister as a clerk in a drug store and a music dealer, engaged in the study of botany during his spare hours and as a result of his devotion to this avocation he eventually began to contribute new facts concerning plant life. In fact, he was

made a professor of botany at Tübingen and became one of the most prolific botanists of the nineteenth century. In our own time we have Dean Berry of Johns Hopkins, who, although he has never graduated from any college, is one of the foremost paleobotanists of the current era. Many other examples could be given to show that it is possible for an individual to master a given field and even to become a dominent figure in this field, without the aid of college professors, but while recognizing this possibility, in defense of my own occupation, and to maintain the peace with my colleagues, I should quickly add that it is only the occasional student who will travel this road independently.

In reading the biographies of our great contributors in the field of science, one frequently encounters statements made to indicate that in the incidents and traits of childhood the genius of the man was foreshadowed. In general these statements and stories may be said to represent mere afterthoughts and therefore they should not be taken too seriously. Evidences of real genius are seldom revealed in the child except to the eyes of the fond parent who is quite apt to see in his baby boy a budding genius. Experience teaches us that such super-children are often more likely to become piano tuners than master musicians, truck drivers instead of experts in science. As a boy Louis Pasteur was only a C+ student. Although his mind worked carefully, it worked so carefully that he was considered slow. As a schoolboy no hidden spark was discovered in him that foretold the brilliant successes that were to follow in later years. However, if we follow his biography all the way through we shall find that Pasteur worked with absorbing interest, with determination and purpose, and always with a view to mastery. It was this manner of working that attracted Romanet, his teacher, and induced him to take a special interest in the lad, and to try to inspire in him some ambition for his future.

In his book, "New Creations of Plant Life," Harwood makes a rather ludicrous effort to impress upon the mind of the reader the fact that in his earliest childhood Luther Burbank, through his passionate love of flowers, manifested the interest that was to dominate his life. Harwood says, "From his earliest childhood he was passionately fond of flowers. His mother and sister had noticed that when he was given a flower, while lying in his cradle, he always held it with a certain childish tenderness, never crushing it or dropping it but keeping it, if allowed, until its bloom was faded or its fragrance gone. One day when his sister had given him a flower, he held it in his tiny fingers with his usual earnestness until a petal fell off. Then, with infinite childish patience, he strove to put the petal back in place, and thus restore the flower. When a little older and able to walk, he often chose plants for pets instead of animals. He was given a plant in a pot, a so-called lobster-cactus as this variety of cactus was locally known, and for hours at a time he trudged about the house and yard carrying the cactus plant in his little arms. One day he stumbled and fell, broke the plant from its stem and destroyed the pot. It was a day of great sadness, for he was inconsolable in his grief over the loss of the pet plant as another child would have been over the death of a bird or a faithful dog." These stories are certainly to be regarded as nothing more than mawkish distortions of some common and natural childish reactions, and

as such they do not prefigure Burbank, the wizard of plant breeding, any more than they do "Tony," the gardener.

I have attempted to show that research is a term applied to the combined working of curiosity, will, imagination, judgment, observation, and experimentation in the search for new knowledge. I have indicated that such seeking begins in early childhood and continues throughout the period of one's active life. Research is therefore a common experience in which each individual achieves according to his own peculiar abilities. As in any other experience we become more proficient with continued practice, and when we have once mastered a given field, we may extend our inquiries into the realm of the unknown. If our quest is successful we may be so fortunate as to discover some new fact and thus contribute something to the sum total of accumulated wisdom.

May I say here that, in my judgment, the word "research" as commonly used, is restricted too narrowly to the study and investigation of material things. This usage does not express the more inclusive and cultural content of the word. It should include the habit of thought, the course of reasoning, the mental attitude and attack, all of which are developed, quickened and matured in the quest of the unknown. It is this endless development, this unfolding and growth of the inquiring mind that we may properly call the spirit of research.

The reward of seeking is finding. Nowhere is this better illustrated than in the story of Archimedes. It was this old Greek mathematician and philosopher, you will recall, who discovered the principle of specific gravity whereby he was enabled to determine what proportion of silver alloy was contained in the golden crown of King Hiero of Syracuse. According to the story, when he made this discovery, he rushed into the street shouting "Eureka! Eureka!"—I have found it. It is this thrill of victory, this joy in discovery, that sustains and vitalizes the long and patient toil of the research worker.

However, I am compelled to admit that this aphorism, "Seek, and ye shall find," like the responses of the oracle, is somewhat enigmatical. While the investigator is assured that he will find something, there is no assurance that he will find precisely what he is seeking; in fact, we know that he often makes incidental or accidental discoveries, and sometimes these finds prove to be of far greater importance than the specific thing the seeker had in mind at the beginning. The knowledge of fire and the use of metals came into the hands of primitive man probably as a result of accident. But he who sets forth on a search will always find something, and the eager anticipation of what may happen adds greatly to the zest of the chase.

In 1856, W. H. Perkin, a young English chemist, was attempting to produce quinine synthetically. He used allyl-toluidine, potassium bichromate, and strong sulphuric acid. However, when these reagents were brought together, he failed to get quinine, but some sort of a colored product was the result. For most chemists the experiment would probably have ended here, but this unexpected result aroused Perkin's curiosity. He repeated his experiment, substituting aniline for the allyl-toluidine, and this time a black residue was formed.

By extracting this substance with alcohol he succeeded in dissolving out a lilac coloring matter which was later to become the commercially valuable aniline-violet. This was the first coal-tar dye and it was the result of an accident which excited the curiosity of Perkin's inquiring mind.

In 1896, the French physicist, Henri Becquerel, attempted to show that X-rays are the result of the fluorescence produced in glass by the impinging cathode rays. He placed a salt of Uranium, which fluoresces when exposed to light, on a photographic plate well protected from the action of ordinary light. Later when this plate was developed a dark patch appeared indicating that the uranium salt had emitted a radiation that had penetrated the wrapping. This result seemed to confirm Becquerel's hypothesis. However, while trying to repeat this experiment, he was interrupted, and he placed the protected plate with the uranium salt in a dark cupboard where it remained for some time. Now since uranium salt fluoresces only when exposed to light, Becquerel did not expect that any effect would be produced. However, he developed the plate and was much astonished to see an image appear that was fully as dark as the one produced when the uranium salt was exposed to light. This showed that the action on the plate was not caused by the fluorescence of uranium salt. Thus by mere chance Becquerel was led to the discovery that uranium compounds continuously and spontaneously emit "rays" or radiations which have the power of passing through wood, paper, and other opaque materials, and of affecting a photographic plate in a manner similar to X-rays. Therefore we may say that radioactivity was discovered by accident.

But you will ask me why men and women should devote their lives to research? Does the work pay well? What are the attractions? In reply to these questions I must say at once that a research career promises no enticing monetary rewards. Very few men among those who have spent their lives in research work have shared largely in the wealth they have helped to create. It would be utterly false to state that the desire for money prompts men and women to enter the field of research. On the contrary, I believe it is partly the spirit of adventure and more largely the spirit of service that supplies the motivation for this choice.

In each one of us there is an innate urge to render some service to our neighbor, to do something for someone else. This urge may be suppressed or it may be fostered and encouraged in early childhood. In those cases where it has been developed there is usually manifested an expanding sympathy and fruitful service for human kind in general. I believe that the great majority of our investigators, wherever they may work, and whatever the nature of their work, are motivated chiefly by this inborn desire to do something that will be of some benefit to mankind. Just a few years ago one of these research workers said: "There is a spirit of service which is a service to both God and man. When a man dies he hopes to leave the world a little better than when he came into it. This may be through the activities of the industrialist who makes available power from unused resources, the engineer who harnesses the forces of nature, the railroad man who opens new country, the poet who "unfolds new thoughts and sentiments and the beauty of life in a stimulating phraseology that reaches our listening ears, or the musician who stirs and

ennobles the soul, with beautiful uplifting melody or symphonic treatment of themes. Thus the research spirit is by no means confined to materialists and to material things."

There is an inscription on the beautiful dome of the building of the National Academy of Sciences and National Research Council in Washington which reads as follows: "To science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of nature's law, eternal guide to truth." This is a summary of the results of scientific research. It has been responsible for the creation of new industries, elimination of wastes, elimination of drudgery, more efficient use of our natural resources, increase in the productivity of agriculture and better preservation of these products, dissemination of information, prevention and cure of disease, and increase in human comfort. For all of these innumerable benefits, civilization is indebted to those men and women who toil quietly, patiently and persistently in research laboratories; whose rewards are primarily the satisfaction that comes from the knowing that work has been well done, the good-will and praise of their fellow workers, and a stipend that too frequently is insufficient to free the mind of the recipient, of anxiety concerning the demands of the tailor, the baker, the butcher, and the landlord.

The aggressive inquiring mind is not much concerned about rewards and salaries. Absorbed in the search for truth, and sustained by the joy of work, such a mind delves patiently and earnestly for new wisdom. We have been told that Steinmetz received no regular salary. His personal needs were few and his standard of living was modest. The General Electric Company made provision for him to draw upon them for money whenever he wanted it. But Steinmetz did not work merely for a salary check; he had a far nobler motivation. He loved his work and lived for his research. In the enjoyment of his work and appreciation of the great possibilities inherent in research, he undoubtedly shared the feeling of Lavoisier, the great French chemist, who just a short time before he encountered a premature and unjust end by the guillotine, wrote: "To merit well of humanity and to pay tribute to one's country it is not necessary to take part in brilliant functions that have to do with the reorganization and regeneration of empires. The naturalist may also perform patriotic functions in the silence of his laboratory and at his desk; he can hope through his labors to diminish the mass of ills which afflict the human race or to increase its happiness and pleasure; and should he by some new methods which he has opened up prolong the average life of man by years or even by days he can also aspire to the glorious title of benefactor of humanity."

This is the creative spirit which Mr. Kipling certainly had in mind when he wrote:

> "And only the Master shall praise us, and only the Master shall blame;
> And no one shall work for money, and no one shall work for fame.
> But each for the joy of the working, and each in his separate star,
> Shall draw the Thing as he sees It for the God of Things as They Are."

TEACHING AND RESEARCH*

WITH AN ACCOUNT OF PRACTICES IN THE UNIVERSITY OF NEW ATLANTIS

E. P. Lyon, Dean of the Medical School
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Words are interesting things—interesting beasts of burden. They tend to travel in pairs. Sometimes they pull together in team fashion. More often they balk and work against each other.

For example, heredity and environment. They are always fighting as to which is most important. Environment seems to feel that if she could get rid of heredity, she could have the pasture to herself. This is true enough. But a universe with nothing in it but environment does not present an alluring prospect. Heredity thinks he could run the whole circus alone, but every time he sets up the ring, there is old environment already on the ground.

As regards the work of this team on the human farm, it seems that heredity gets the worst of it. Nobody seems to care whether the beast lives or dies. We have thousands of schools, colleges and churches to help out environment; hundreds of hospitals, parks and playgrounds; dozens of libraries, social agencies and foundations—all busy smoothing the road for environment; while old heredity stumbles along in his blind way without even a comfortable stable at night.

Of course, as regards the lower animals and useful plants, we quite reverse our practice. No one has ever endowed a college for improving cattle by means of environment, but there are plenty of breeding farms where heredity holds full sway. There are no churches, hospitals or art galleries for pigs. All that environment furnishes is a trough, a concrete floor and a pile of straw. But heredity works freely to change the razor-back into the Poland China. It's the same way with dogs and chickens and grapefruit and raspberries.

Well, I will have to leave it to the audience whether our men are better than our raspberries. I am merely pointing out the conflict between heredity and environment and raising the question whether the team is working to the best advantage.

There are other toiling spans on our highways that might stimulate our thought: labor and capital—magnificent Percherons which behave like spoiled colts; industry and agriculture—industry attempting to nose agriculture away from the oat bin; ideal and possible hitched tandem—ideal prancing in front and possible pulling the load. But I shall not permit my imagination to play with these ill-assorted harness mates.

What of teaching and research? Teaching, drawing the chariot which bears the cherished accumulations of mankind. Research, a steed of Phoebus, neigh-

* This paper was dug out of the "barrel." Internal evidence shows it was written about 1928, and was intended for an audience interested in medical education. Where it was read—if it was read—the writer cannot recall.

ing at the dawn. Teaching—if we may drop the figure of horses and take that of the runner—passing on the torch. Research, pursuing strange paths, seeking new light. What horses—what runners, are these!

We say that the functions of the university are teaching and research. Of what relative importance? How related in college organization? The answer to these questions fixes educational policy, selects faculty members, puts its mark on students, affects building plans, determines budgets.

First, teaching. In the broad sense, it is *sine qua non*. Unless the experiences of each generation had been passed on to the next, there could have been no civilization.

Of course, many people teach besides those we call teachers; but in the processes of universal education to which this country is committed in the belief that it is the prime support of democracy, formal teaching and the professional teacher are essentials.

Moreover, teaching becomes more and more the avenue of approach to other activities. More and more in industry and commerce one notes the organization of teaching. Banks conduct instruction for their young clerks. The great electrical manufacturers pass their young men from department to department, with definite teaching programs, for a year or more before placement. They find that the investment thus made in trained youth pays in better and greater production. They invest in teaching as they do in machinery, because it pays.

For myself I need nothing more than this widespread recognition of the value of teaching by hard-headed managers of corporations to convince me that the teacher is a main wheel in our civilization. I am strong for teaching and proud that I selected teaching as my profession and have been for forty years a teacher.

Teaching is an art—surely that. There are poor and mediocre teachers just as there are poor and mediocre pianists. There are master teachers just as there are master musicians, painters or architects. Teachers of the highest grade are as scarce as are the masters of any craft.

If you are not willing to accept that statement as self-evident, just roll back your memory and ask yourself how many of your teachers left a real impression on your life. If you had one honest-to-goodness teacher, you were fortunate.

Now all of us here present are either engaged in or at least interested in medical education. We are taking the best young men and women we can find—a highly selected group on whom already a large amount of time and teaching has been expended—and are training them to be doctors. They have already cost their parents and society a large sum. They are going into a profession where they will need an assortment of scientific facts, various and difficult techniques, refined powers of observation and deduction, and trained judgments which may be called upon to make life and death decisions. They are going, moreover, into a profession where they must display a humanity and knowledge of people which will make them acceptable to those who may need their help.

Who is to select from the accumulated libraries the facts these young people will need? Who is to train their powers of observation? Who is to instill,

if it be possible (which I sometimes doubt), that which we call scientific thinking? Who is to create the critical judgment that will enable the young doctor to stand by himself in a world of advertising and propaganda, of exaggerated claims and false statistics? Who, perhaps most important of all, is to protect the public from the incompetent and unreliable physician? Why, it's the medical teachers!

No medical school is worthy the name that does not look upon its teaching function as a serious responsibility. No medical school is worthy that does not scrutinize prospective faculty members as to their proficiency in the teaching art.

The good teacher should be fostered, properly paid and given honorable recognition. If he is known to generations of students as one whose teaching has been really stimulating, you need not scrutinize his bibliography nor look too closely for his name in "American Men of Science."

Two of the world's immortals are he who walked and taught in Athens and He who walked and taught in Galilee, and neither of them ever wrote a line. They are known and will always be known by their "works" and not by their arbeits.

As an artist the teacher loves his work. Before his eyes the growing powers of his pupils take on color and beauty as does the canvas of the painter. He looks here and there among the rising generation upon those of his pupils who have won fame or performed high service, and he is proud. See, for example, the list of famous graduates of the University of Michigan that Dean Vaughan sets down in his autobiography. Next to the children of his loins, the teacher loves his intellectual progeny.

When I hear a faculty member complaining of the work of teaching, of the time "wasted from research," I doubt whether he is in the right place. I doubt whether he is a good teacher. I am certain he has not that passion for teaching—the artist's passion—which I have tried to depict.

Just one more thought; I doubt whether many medical teachers have ever prepared themselves to teach. They are prepared in the material to be taught, but not many have given attention to the methods by which that material may be most effectively presented. This is quite different from the custom in primary and secondary education. I am not advocating that our medical teachers attend normal school; but I do call attention to the excellent books on teaching which are available, and to the usefulness of observing good teaching, and to the value of serious thought by the teacher on what and how he shall teach.

And research. What of this function of our medical institutions?

As to the value of research as a contributor to human comfort and well-being there can be no question. That the medical man should know the source of his facts, materials and methods, that he should be able to think of each case before him as a research problem, that he needs poise, ability to suspend judgment, power of making a critical analysis of data, and the experimental mind—these again, I take it, are self-evident facts. Both because of its contributions to knowledge and welfare, and because of its reflex effects on the educational process, I am strong for research in the medical school.

Considering the second of these reasons, and also the first in its broader implications, it appears that research should be close to teaching. They should

be integrated. Research is not something to be shut out from student participation—in another building, perhaps, to which the elect may be initiated, while the ordinary student looks at the outside with awe as at some kind of secret fraternity. No, I say research and teaching should be harnessed together and should pull together.

By means of electives, problem courses, student assistantships and all other aids, the students should be brought into the research program. Journal clubs and seminars should be open to students, and they should take part. Intimate relations with the graduate school, with consequent possibilities for advanced degrees, will assist the medical school in bringing the research ideal to its students.

Integrate teaching and research. Recall that Helmholtz, standing before his students, asked himself why the pupil of the eye appears black and forthwith invented the ophthalmoscope; asked himself whether it be true that the nerve impulse takes no measurable time to travel and proceeded to measure its velocity.

Teaching of the right kind suggests problems. I recall Jacques Loeb standing before his class in physiology at Chicago. In his slight German accent he might say, "Now, dis is zo"—a long, thoughtful pause, then vehemently, "No, it might be zo! Garry, we must try dat; Lyon, we must try dat!" That kind of teaching by that kind of a researcher is an inspiration to students. To my mind, science lost rather than gained when Loeb left the university for the research institute.

There is another aspect of this relation of research and teaching. The world has an enormous stock of undigested and unused results of research. If the facts known right now could be applied, it is asserted that the average length of life could be increased ten years. While one may question the exact figure, the general truth of the statement cannot be doubted.

There is a serious side to this unabsorbed gorge of science. It has given our people a bad indigestion. It lies in the public stomach and troubles their dreams. They do not know enough to know good science from bad. They have an unjustified reverence for anything which assumes the name of scientific. They think all things are possible. They run after strange gods—chiropractic, Christian Science (the woman who invented that phrase had genius), cancer cures, and so on. They listen to deceptive advertising couched in scientific terms. The superstitions of science are as widespread and vicious as, in another day, were those of demonology and magic.

So serious is the problem of research accumulations and the misunderstanding of the common man relative to it, that some have advocated that research ought to stop until humanity can catch up with it. "Give us a truce in research," they say. Haldane raises the question thus: "Has mankind released from the womb of matter a Demogorgon which is already beginning to turn against him and may at any moment hurl him into the bottomless void?" He argues "Not," but I suspect he fears.

Admitting the confusion of popular thought, which compared with the sureness and stability of the state of mind in the Middle Ages, is as a pyramid turned on its apex, I am not ready to stop research even if I were able. Considering our own field only, such boons as antitoxin, salvarsan and insulin,

coming at intervals in our own lifetime, offset, I judge, the misconceptions and misapplications of science, the vagaries and false hopes to which partial knowledge gives birth.

What the world needs is not less science, but more knowledge of what science is and what it can and cannot do. What the world needs is more and better teaching. I favor research not only because I value new knowledge, but also because I believe that each well-trained student will become a teacher who will help illuminate the popular mind; for every doctor is primarily a teacher. If he knows what research is and what it demonstrates and what the limitations of science are, he may be able to instruct his patients in these important matters.

It is hard for us to realize, but to the untrained, "subluxation" of vertebræ seems as logical a cause of disease and more understandable than foci of infection. To the uninitiated, the chiropractic "thrust" is as logical as the hypodermic thrust. You may blame people for not knowing, but ask yourself how the ordinary man could learn about medical science—learn to tell true from false. It is the business of doctors to teach the people so that they will know and will discriminate.

Yes, I am strong for research but equally strong for teaching. I think we should do everything possible to develop the expository art. I think we should not only teach our students, but also teach them how to teach. I think such men as Slosson and Doctor Evans are performing service as important as any investigator anywhere. I agree with Haldane when he says, "I am absolutely convinced that science is vastly more stimulating to the imagination than are the classics, but the products of this stimulus do not normally see the light because scientific men, as a class, are devoid of any perception of literary form." Perhaps it would be a good thing to stop research for ten years and devote our laboratories to the teaching of reportorial English.

But now, if the speaker is so strong for research and so strong for teaching, you are asking how he would relate the two in medical school activities. You want to know how he would hitch up the team, how he would adjust the whiffletree, which horse should have the choice place at the manger, which should get the larger measure of corn.

The speaker acknowledges he has no universal formula for answering these questions. He is inclined to say that it is the first duty of a medical school to see to it that its teaching is sound, practical and effective. It owes this duty to its students and to all the people whose lives will be affected by these students. Nevertheless, the speaker is convinced that the best teaching is carried on in a research atmosphere. In his own case he knows that his mind was not fully opened in the small college where the word research was never heard and that a new world was revealed to him when he entered the university.

The speaker is inclined to say that every medical school, no matter how inadequate its budget, should have on its faculty a few men who are interested in the extension of knowledge, but he is equally certain that not all schools should attempt to imitate the great universities, with their large faculties, libraries, equipment and endowments. He ventures to assert that forced research is as bad as none at all.

At least one unselfish thought the small school should have in mind is to pick out its bright and original young men and see that they go to the places where they may get inspiration and leadership which the lesser institution may not provide. This is indeed the finest trait of a teacher—that he send his best pupils on to heights which he himself may not attain.

The best example, I think, to which I can refer the average school in making its adjustments between research and teaching is Salomon's House or the University of New Atlantis. I find only one description of this famous institution and apparently, before my visit last summer, it had been surveyed but once by a man of our race, the famous Sir Francis Bacon, whose travels took him to this far country a little over three hundred years ago. His book, "The New Atlantis," appeared posthumously in 1627.

Bacon states that Salomon's House or the "College of the Six Days' Works," was already 1,900 years old when he was there, which makes it by far the oldest university in the world. You will further recall that while Bacon sojourned in the Island of Bensalem, which is the natives' name for New Atlantis, one of the fathers of Salomon's House came to the city. This is Bacon's description of this revered educational leader:

> "He was a man of middle stature and age, comely of person, and had an aspect as if he pitied men." (From this last remark I assume he was the college president or possibly a dean.) "He was carried in a rich chariot, without wheels, litter-wise, with two horses at either end, richly trapped in blue velvet embroidered; and two footmen on each side in the like attire." (From this description I conclude he could not have been a dean. He must have been the president.) "He had before him fifty attendants, young men all, in white satin loose coats to the midleg; and stockings of white silk, and shoes of blue velvet; and hats of blue velvet, with fine plumes of divers colours, set round like hat-bands." (I conclude that these were not instructors on the faculty but rather sons of rich trustees.)

A little later, it will be recalled, the Head of Salomon's House granted an interview to Francis Bacon and this is what he said regarding the purposes of his institution:

> "The end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible." (Where, I ask, will you find a better definition of the aims of research?)

Then he went on to inform Sir Francis in regard to their facilities. They had caves three miles deep beneath the mountains, towers high above the hills, great lakes—both salt and fresh—for experiments on fish and fowl, meteorological laboratories, orchards and gardens for experimental purposes.

They had institutes for animal experimentation, and it is easy to read into Bacon's description that they knew the ductless glands and had anticipated Mendel. They had brew-houses and vineyards (it is painful in these days to read of these as educational adjuncts). They had dispensatories and chemical

laboratories, "glasses and means to see small and minute bodies" (this was written nearly fifty years before the compound microscope was invented in Europe). They had "sound houses" and the descriptions of their instruments fit our phonograph, amplifier and telephone; they had airships and submarines; they even beat us by having perpetual motion. They had "houses of deceits of the senses," which I interpreted as psychological laboratories.

Then Bacon gives us a remarkable account of the staff or faculty, which is too long to quote, but the last paragraph reads as follows:

> "We have also, as you must think, novices and apprentices, that the succession of the former employed men do not fail; besides a great number of servants and attendants, men and women." (They were not stingy about assistants, technicians and stenographers.)

And how did these people regard their scientific investigators? How did they look upon the works of Nature? And how did they spread abroad for use of the people the results of their research? Thus saith Sir Francis, who got his words from the Father of Salomon's House:

> "For our ordinances and rites, we have two very long and fair galleries; in one of these we place patterns and samples of all manner of the more rare and excellent inventions; in the other we place the statues of all principal inventors. For upon every invention (*i.e.*, research) of value we erect a statue to the inventor, and give him a liberal and honorable reward."
>
> "We have certain hymns and services, which we say daily, of laud and thanks to God for his marvellous works, and forms of prayer, imploring His aid and blessing for the illumination of our labours, and the turning of them into good and holy uses." (It might be useful to introduce this practice into our own laboratories.)
>
> "Lastly, we have circuits or visits of divers principal cities of the kingdom, where, as it cometh to pass, we do publish such new profitable inventions as we think good." (This is university extension.) "And we do also declare natural divinations" (that is prognosis), "of diseases, plagues, swarms of hurtful creatures, scarcity, tempests, earthquakes, great inundations, comets, temperature of the year, and divers other things; and we give counsel thereupon, what the people shall do for the prevention and remedy of them." (In other words, they taught the people. Teaching and research, in modern parlance, were the functions of the University of New Atlantis.)

Full as is the description which Bacon gives of that university, it is noticeable that he has little to say concerning organization and nothing at all about budget. It was to gain information on these subjects, as well as to note any changes which might have taken place in the years since Bacon's visit that I made the long voyage to the Island of Bensalem last summer.

It is Heinrich Heine who states that when he was in hell in dog days the heat was intolerable. Quite opposite is the New Atlantis in August. It is a cool and pleasant country, and I recommend the trip to any tired professor who

desires rest and novelty during the coming long vacation. A few days at the university will be worth any visitor's time. I was there about two weeks and was accorded every courtesy by those in charge.

The great earthquake and tidal wave of 1897 destroyed much of the older establishment. Naturally the people of a country which so long has recognized the university as the foundation of its culture and backbone of its prosperity were not slow in rebuilding this famous seat of learning.

The new buildings are substantial but plain. They are not scattered over a very large plot of ground, the idea of quick and easy communication having been prominent in the minds of the architects and educational leaders. I shall not enter into any detailed description of the plant more than to say that it is adequate under the ideals prevailing among these people. It is not at all like certain "medical centers" in our country.

By some magic the university authorities compelled the architects to devote more attention to the inside than to the outside of these buildings. I was told, in fact, that any architect whose building fails of the purpose for which it was intended is quietly strangled, no matter how beautiful the exterior may be. This insures utility and convenience.

No effort is made to set aside buildings for particular sciences, it being recognized that all the great body of observational knowledge is a unity, and that workers in any field profit by contact with others in quite different fields. Similar reasoning leads to equal attention being paid, side by side, to recondite researches of no apparent practical value, and to industrial applications of immediate importance to the welfare of the people.

Another unique feature is the total absence of schools and colleges. The unit is the department. All teachers and investigators in a given field are associated for purposes of administration and mutual aid.

Even curricula in our sense do not exist. A student of medicine, for example, will find no fixed order of required studies. Rather he is supplied with a list of subjects in which he will be required to qualify, a second list from which certain choices are to be indicated, and a general statement of the aims of the profession he desires to enter. A committee from interested departments settles and administers with full authority professional requirements, examinations and student programs. I was surprised to find students majoring in such diverse subjects as sanitary engineering, psychology, biometry and sociology and all looking confidently forward to the M.D. degree.

The term, curriculum, the president explained, is avoided as it implies a race track in which all run a common course. The native word, employed in educational guidance, is "ogoon," somewhat crudely translated as "proving ground."

In matters of athletics also the Atlantians have original ideas. As soon as a student shows superior interest in sports he is relieved of all class work. If he makes a university team, he is graduated *cum laude*. Those who attain a status equivalent to "all-American" receive *summa cum laude* degrees. From the athletic alumni are recruited policemen, stevedores and officers of the army.

These features of the university, good as they appear to be, were not, however, the ones which struck the American observer as of chief importance or

worthy of most serious consideration in our country. Rather it was the original and apparently satisfactory manner in which the old conflict between research and teaching has been settled, and the resulting unique salary system which has been adopted.

The president of the New Atlantis University in explaining this matter said that all educators are, of course, agreed that both the passing on of old truth or teaching and the search for new truth or investigation are essential functions of any institution of higher learning. But nowhere before has any serious effort been made to evaluate comparatively these two functions and build up a budget and administration on such principles. After much discussion he said it was concluded that the two services are of equal value to the state and upon that basis the whole university is conducted.

The next step was to divide the university income, after allowance for general overhead and upkeep, into two equal parts. One-half of the available funds is devoted exclusively to instruction. A special committee of faculty members particularly qualified and interested in teaching makes the instructional budget. Proper allowances are made for the purchase of teaching materials, such expenses being controlled through the teachers' committee. The rest is used for salaries and distributed primarily on the basis of teaching ability, with some allowance for age, experience and number of offspring.

The other half of the funds is used exclusively for research and a committee of the wisest and most far-sighted scientists plans expenditures under this budget. They set aside money for the purchase of equipment, the hiring of technical help and the furnishing of materials; and this fund, again, is expended under the direction of the scientific committee, which also settles the salary allowances on the research side. This is done wholly on the basis of power to pursue original investigation and ability to lead and train investigators.

It will be seen at once that a given individual's salary as shown in the budget is made up of two items, one for teaching, the other for productive scholarship. It will also be seen that an excellent teacher without research ability and a fine investigator without talent for teaching may get equal salaries. A man fair in both particulars but not outstanding in either may receive about the same salary as the other two. But one who is at the same time an outstanding teacher and a researcher of distinction will receive double the salary of any in the group just mentioned.

And so it goes with all. Each faculty member is judged as to his value to the university in each of the two functions which the institution acknowledges, and each judgment is made independently by a jury of peers in the particular function under consideration, teaching by teachers, research by researchers.

Salaries are readjusted annually, with the result that young men of promise and activity often get larger stipends than older men who have shot their wad.

Persons of good morals, willingness and courtesy but who can neither teach nor investigate are appointed as deans, registrars, business managers and janitors.

The president says the plan is working well, and that under it he is relieved of all responsibility.

OBJECTIVES AND MARKS OF THE TRUE SCIENTIST

C. E. SEASHORE

A study of the lives of great men in science reveals certain objectives of a learned career which we would do well to set up as our real goals in the acquisition of learning:

INSIGHT INTO NATURE

Nature is the object of our search. Knowledge of fact is a tool by which we may chisel out the profiles of truth and make them live. If we acquire all knowledge and have not insight or understanding, our knowledge will be but the rattling of dry bones.

APPRECIATION OF ITS BEAUTY

Science is not cold, disembodied fact. Knowledge of nature without a deep and irresistible love for it is like marriage without love. No real progress in research is made unless the investigator falls very deeply in love with his cherished object and expresses his love in his daily life. Therefore, shun not sentiment. Radiate your love for the blade of grass, the ant, the atom, the unfolding strata of earth's creation, the twinkling star, the human life. They are all one, the unfathomable, which we can never fully know, but which it is ours to live in and enjoy. Live in them now; the present moment is a vital part of eternity.

WISDOM IN ITS CONTROL

The term efficiency has brought science into disrepute. It has made of the scientist a mechanical robot. The laboratory solutions of the problems of life, however penetrating and exhaustive, are, like all other isolated facts, merely a skeleton on which we must grow flesh and blood in the process of maturation. Wisdom is a mellow philosophy of life, as opposed to a mechanical control.

Therefore, emblazon a golden motto in the corner of your mirror: INSIGHT, APPRECIATION, WISDOM.

But there are three other goals which condition the acquisition of the art of skill in science. Indite these in your private diary. Live with them without ostentation. Breathe not a word in regard to your sacred ambition; but tremble, knowing that the world is to be your judge.

THE DEVELOPMENT OF PERSONALITY

The greatest service rendered by the current movement in intelligence testing is the revelation that intelligence is not the sole or dominating characteristic of effective living. Personality consists of a hierarchy of capacities, aptitudes,

and skills in which knowledge takes the form of insight; learning takes the form of appreciation; and will-power takes the form of wisdom.

SCIENTIFIC INTEGRITY

Science is the pursuit of truth. Truth is not merely verbal or meticulous statement of fact. It is the spirit of truth that is sacred to the scientist. As scientific integrity, it is in the warp and woof of his character. During the Great War a scientific committee clashed with the government because one of its members had said in public utterance, "The lawyer may lie; the merchant may cheat; the soldier may kill; but the scientist must tell the truth."

EUPHANY

To meet a need in the field of educational concepts, I have coined the word "euphany" with its adjective "euphanous," which means the art of deliberate and adequate statement of fact. This is a trait for which some inherit aptitude, but all require persistent practice in the process of scientific maturation. It involves two elements: the art of deliberation, which means the withholding of judgment for analysis and criticism; and adequacy in the statement of fact.

These are the marks of a true scientist: PERSONALITY, SCIENTIFIC INTEGRITY, EUPHANY.

Benefactions of Surgery to Man

(*Concluded from page 194*)

of custom and dogma. You may have been unable from these comments to decide whether surgery is a trade, craft, art, or science. Leonardo da Vinci, one of the world's most resplendent figures of all time, recognized no great difference between handicraft, art, and science. The surgeon worthy of the name combines in liberal measure the love of humanity, science and craft. However one may choose to designate the activities of the surgeon, it is a privilege to relate something of the most beneficent achievements for mankind in the annals of man.

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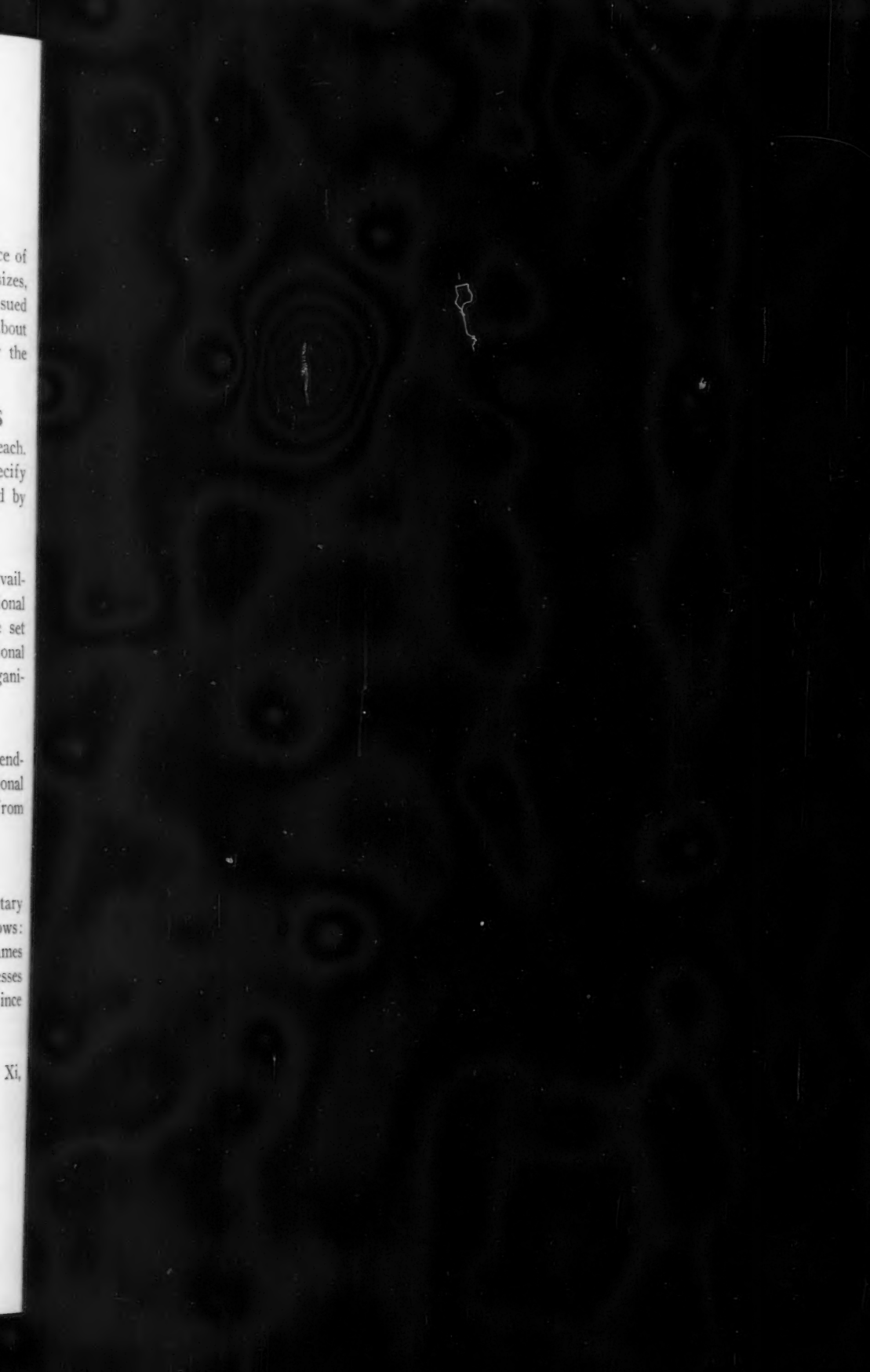
Printed copies of the National Constitution, containing all amendments to date, and all recent interpretations as made by the national officers on request of chapters, are available at 9 cents each from the National Secretary.

CHANGES OF ADDRESSES

Chapter secretaries are asked to send to the National Secretary in October of each year changes in their enrollment lists as follows: 1. Names and addresses to be deleted from the previous list; 2. Names and addresses to be added to previous list; 3. Changes of addresses of those on previous list who may have moved to a new address since the list was submitted.

EDWARD ELLERY,
National Secretary, Sigma Xi,
Union College,
Schenectady, N. Y.